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РЕЗЮМЕ

КСИЛОТОМИЧЕСКОЕ ИССЛЕДОВАНИЕ ВИНОГРАДА

А. ХЕГЕДЮШ

Авторы изучали ткани многолетней древесины у 16 сортов *Vitis vinifera*, а также по одному сорту *V. labrusca* и *V. riparia*, происходящих из 5-ти мест произрастания в Венгрии и из 2 мест из-за границы (рисунки 1—8), и определили размеры разных элементов (таблица 1). Установлено, что нет резкого структурного различия между различными образцами, но по размерам имеются достоверные различия. Причинами отклонений оказались частично различия между сортами, частично же различия по экологическим условиям мест произрастания. Степень участия двух факторов можно выяснить в ходе дальнейших опытов.

ПРОДУКТИВНОСТЬ ПЫЛЬЦЫ И ВЫБРАСЫВАНИЕ ПЫЛЬНИКОВ У ПШЕНИЦЫ (*TRITICUM AESTIVUM* L. EM THELL.)

Й. МИЛОНИЦ, М. ЙОСТ

При производстве гибридной пшеницы хороший опылитель кроме хорошей комбинационной способности и восстановления фертильности должен обладать высокой продуктивностью пыльцы и способностью выбрасывать пыльники. В 1968 и 1969 годах изучалась продуктивность пыльцы, а также скорость и интенсивность выбрасывания пыльников у 26 сортов пшеницы. Сорта достоверно отличались по: проценту и скорости выбрасывания пыльников, размеру пыльников и числу пыльцевых зерен в пыльнике. Корреляционный коэффициент между длиной пыльников и числом пыльцевых зерен в пыльнике был 0,87, а между шириной пыльников и числом пыльцевых зерен в пыльнике — 0,54. При селекции генотипов с большими пыльниками продуктивность пыльцевых зерен в пыльнике повышается.

Имеется достоверная положительная корреляция между продолжительностью вегетации и длиной пыльников ($n = 0{,}54$), но она отсутствует между длиной вегетации и шириной пыльников ($n = 0{,}13$). Мы не смогли найти корреляции между процентом выброшенных пыльников и другими изученными признаками.

Полученные результаты могут быть полезными при выборе лучших опылителей при синхронизации цветения родительских пар в процессе производства гибридны семян.

ПРОБА НА ТЕРПЕНОИД, ПРИСУТСТВУЮЩИЙ В ЧАСТЯХ *CORIANDRUM SATIVUM* L. III. ГИСТОЛОГИЯ РАЗВИВАЮЩИХСЯ СТРУКТУР *CORIANDRUM SATIVUM* L. СОРТА «ЛУЧ» И СВОЙСТВА СОСУДОВ ЛЕТУЧЕГО МАСЛА

Ж. ЛАШАНИ, К. ЛЁРИНЦ

Были проведены гистологические исследования у *Coriandrum sativum* L. сорта «Луч» в течение его онтогенеза. Установлено, что сосуды летучего масла вегетативных органов и эпителиальные клетки периферических сосудов плодов не являются опробковевшими. Более того, отклонение может быть обнаружено только в отношении их топографии и размера. В противоположность этому, эпителиальные клетки внутренних сосудов лодов являются опробковевшими.

ВЛИЯНИЕ МАЛЕИНОВОГО ГИДРАЗИДА НА СТРОЕНИЕ ЦВЕТКА БАКЛАЖАНА (*SOLANUM MELONGENA* L.)

ДЬ. ПАЛ, Е. ОЛАХ

Вводя в главный ствол соцветия баклажана 1 см³ раствора 0,01 процентного малеинового гидразида только один раз, внутри одного соцветия влияние раствора малеинового гидразида повлияло почти на все фазы спорогенеза. В результате введения раствора в отдельных цветках соцветия появляются разные изменения. Полученные изменения (отсутствие тычиночной нити, отсутствие пыльников, отсутствие пыльцы, стерильность пыльцы, одновременное появление стерильной и фертильной пыльцы, нераскрывающиеся пыльники, содержащие фертильную пыльцу, раскрывающиеся пыльники с фертильной пыльцой) показывают связь между строением соцветия, генезисом микроспор, апперцией пыльников и влиянием раствора малеинового гидразида.

БИОЛОГИЧЕСКОЕ И ЭКОЛОГИЧЕСКОЕ ИЗУЧЕНИЕ ЛИСТОВОГО МИНЕРА ЛУКА, *DIZYGOMYZA CEPAE* HER.

Л. М. ШАНАБ, С. БОГНАР

Опыты были проведены с 1965 по 1967 г. с целью определить время наличия, густоту популяции, эволюцию инфекции и восприимчивость различных сортов лука к инфекции ***Dizygomyza cepae*** **HER.** Кроме того опубликованы данные о наблюдении над личинками, местах минирования и периоде окукливания.

ДЕЙСТВИЕ КАПТАНА, ЗИНЕБА И ДИТИАНОНА НА ЗАЩИТУ ЯБЛОНЬ ОТ ПОРАЖЕНИЯ *VENTURIA INAEQUALIS*

Ж. ДАНЧ, З. ЧОРБА, Б. И. ПОЖАР

Основное заражение *V. **inaequalis***, равняющееся 34—51 процентам на листьях и 60—85 процентам на плодах, снижалось в двух совхозах под действием азотсодержащих фунгицидов соответственно в четыре и двенадцать раз. В сравнении с 58—85 процентами токсичности (обжигание) плодов, вызванной оксихлоридом меди, опрыскивание каптаном **(Orthocid)** и зинебом **(Aspor)** не вызывало контрастной токсичности плодов ни одного из трёх исследованных сортов яблонь (Йонатан, Золотой деликатес, Старкинг). Дитианон **(Delan)** вызывал сетчатую пятнистость плодов у более чувствительных сортов яблонь (Золотой деликатес) с частотой около 47 процентов, поэтому дитианон не может быть использован на этом сорте. Ни один из азотсодержащих фунгицидов не вызывал пятнистости фитотоксического происхождения. Красная окраска кожуры плодов, очень важная с точки зрения коммерческой ценности, вызывалась действием дитианона до 98—99 процентов у значительной части плодов. Учитывая этот высокоблагоприятный побочный эффект, дитианон в будущем надо будет в значительной степени широко использовать для предохранения сорта Йонатан от заражения *V. **inaequalis***. Сравнивали с контролем три исследованных фунгицида, вызывавших усиление роста побегов на 44—64 процента до конца вегетативной стадии (31. VIII). Этот благоприятный побочный эффект также оправдывает применение азотсодержащих фунгицидов в яблоневых садах.

Действие зинеба чрезвычайно кратковременное, так как при опрыскивании им через 8—10 дней результаты были неудовлетворительными. В случае относительно высокой степени основного заражения каптан был непропорционально менее эффективным против *V. **inaequalis*** в сравнении с дитианоном, поэтому последний предпочли первому для защиты сортов Йонатан и Старкинг.

ИЗУЧЕНИЕ РАЗВИТИЯ СТРУЧКА ТРЕХ ТИПОВ АРАХИСА (*ARACHIS HYPOGAEA* L.)

А. ХАР-ЦУК

Изучалось влияние условий среды в зоне цветения и опробковения на развитие плодов у трех типов культивированного арахиса. Изученные типы реагировали по разному на условия среды в зоне опробковения. Наблюдалась транслокация питательных веществ из корневой системы в развивающийся стручок. Оказалось, что количество питательных веществ является достаточным для нормального развития стручков всех трех изученных типов.

ЦИТОГЕНЕТИЧЕСКОЕ ИЗУЧЕНИЕ МЕЖВИДОВЫХ ГИБРИДОВ *NICOTIANA*

Л. СИЛАДИ

Межвидовая гибридизация в пределах рода *Nicotiana* вызывает стерильность в потомстве, что устранимо полиплоидизацией F_1. Среди полученных автотетраплоидов только растения *N. bigelovii* оказались стерильными. В роде *Nicotiana* единственный фертильный диплоидный межвидовой гибрид — *N. paniculata* × *N. knightiana*. В первой метафазе мейоза во всех случаях образуются 12 бивалентов, что свидетельствует о генетическом родстве между геномами. Между геномами видов *N. debneyi*, *N. glutinosa* и *N. bigelovii* гомология оказалась минимальной. У выведенных нами амфидиплоидов «нового типа» мейоз проходит нормально, а фенотип их константный.

ИЗУЧЕНИЕ РИЗОСФЕРНОЙ МИКРОФЛОРЫ РИСА

С. А. З. МАХМУД, А. Н. ИБРАХИМ

В настоящем исследовании была изучена ризосферная микрофлора растений риса на различных стадиях роста этих растений. Общая микрофлора, актиномицеты, азотобактер, нитрификаторы и редуценты клетчатки показали в большинстве случаев положительный ризосферный эффект. Это происходит потому, что вокруг корней имеется более высокое кислородное напряжение, больше корневых выделений, растительных остатков, чем в отдельной почве. На основании других данных, *Clostridia*, редуценты фосфора и денитрификаторы дали отрицательный ризосферный эффект. Это обусловлено просто анаэробиозисом, который нарушает микробиологическое равновесие, способствуя росту этих организмов.

ПОВЫШЕНИЕ УРОВНЯ СВОБОДНОГО ПРОЛИНА В БЕДНЫХ ВОДОЙ ЛИСТЬЯХ ПОД ДЕЙСТВИЕМ СОЛЕВОЙ ИЛИ ХОЛОДНОЙ КОРНЕВОЙ СРЕДЫ

Г. ПАЛФИ, Й. ЮХАС

Пролин представляет только очень маленькую часть свободных аминокислот листьев растений, выращенных при оптимальных условиях. Наличие его удается показать с помощью бумажной или послойной хроматографии и в большинстве случаев только при проявлении изатином. Но, если в течении 2—3 дней растения страдают от недостатка воды, содержание пролина в листьях повышается во много раз по сравнению с нормальным количеством.

Скопление пролина в большой степени, как индикатор, сигнализирует о недостатке воды в листьях, даже в том случае, когда в корневой среде имеется достаточное количество воды, но ее поглощение корнем по какой-либо причине задерживается. Физиологическая засуха такого типа была вызвана повышением содержания соли в оросительной воде. Вопреки высокому содержанию общей соли в почвенном растворе или осмотическому давлению корневая система может поглащать воду только с большим усилием, что сиг

нализирует о чрезвычайном повышении концентрации пролина в листьях уже в прошедшие 2—3 дня.

В случае большой разницы между температурами корневой среды и сухого воздуха, циркулирующего вокруг побега, корневая система — из-за ее пониженной активности — не может восполнить потерю влаги при транспирации, впоследствии чего появляется в листьях водный дефицит. Повышение содержания пролина в листьях в большой степени является реакцией на недостаток воды. В ходе нашего опыта низкая температура корневой среды была получена путем охлаждения.

ИССЛЕДОВАНИЕ ВОЗДЕЙСТВИЯ НА РАСТЕНИЯ ВНЕСЕННЫХ В ПОЧВУ ИНСЕКТИЦИДОВ

П. ПОПОВ, Л. ДОНЕВ

Хлорооргани́ческие инсектициды: ДДТ, ХЦХ, линдан, гептахлор, диельдрин и альдрин, примененные на пшенице, фасоли, сахарной свекле и вико-овсяной смеси при обработке почвы, оказывают специфическое действие на рост и урожай растений, в зависимости от интенсивности их применения. Изученные хлорооргани́ческие инсектициды поглощались растениями и накапливались в урожае семян; остаток изменялся от 0,1 по 1,2 ppm.

ИССЛЕДОВАНИЕ РАЗВИТИЯ КОРНЯ У ЯБЛОНИ СОРТА ЙОНАТАН, ПРИВИТОЙ НА ШТАММ М—IV И РАСТУЩЕЙ НА ГЛИНИСТОЙ ПОЧВЕ

Я. ТАМАШИ

В статье рассматривается развитие корня у одной из шестилетних особей яблони сорта Йонатан, привитой на штамм М—IV и растущей на глинистой почве при такой культуре возделывания, которая используется в крупных венгерских фруктовых садах. Из каждого возрастного класса были изучены 9 образцов. Полученные результаты показывают, что прежний метод подрезки, который применяли в течение более десяти лет, не соответствовал ежегодному развитию и ареалу распространения корневой системы.

ИЗМЕНЕНИЕ НУКЛЕИНОВЫХ КИСЛОТ В ТЕЧЕНИЕ ВЕГЕТАЦИИ У НЕКОТОРЫХ ДРЕВЕСНЫХ РАСТЕНИЙ В РЕЗУЛЬТАТЕ ДЕЙСТВИЯ МУТАГЕННЫМИ ОБРАБОТКАМИ

И. МОЛНАР

Авторы проводили определение общего количества нуклеиновых кислот (общая НК), рибонуклеиновой кислоты (РНК) и дезоксирибонуклеиновой кислоты (ДНК) в листьях сеянцев миндаля, абрикоса и персика, выращенных из обработанных мутагенами семян в 1961 и 1963 годах. Данные опытов, полученные при определении нуклеиновых кислот в листьях, показывают довольно однообразную картину у сеянцев всех трех видов плодовых. По исследованиям 1961-го года общее количество НК у сеянцев миндаля, обработанных мутагенами (колхицин, жидкий воздух, облучение CO^{60}) в большинстве опытов уменьшалось, по сравнению с контролом. По исследованиям 1963-го года в начале вегетации общее количество НК оказалось большим, потом постепенно снизилось и наконец остановилось на одном уровне. В течение всего периода исследования у всех трех видов плодовых содержание ДНК показывало наименьшее колебание.

ВЛИЯНИЕ НЕФТЯНОЙ МУЛЬЧИ НА РОСТ ХЛОПЧАТНИКА

Х. М. БАХРАМ

Были проведены полевые эксперименты с целью изучения нефтяной мульчи на темпы прорастания семян, цветение, образование плодов и урожай хлопчатника. Установлено, что нефтяная мульча повышает температуру почвы на несколько градусов, что ускоряло рост хлопчатника путём ускорения прорастания семян и плодоношения у растений и привело в результате к увеличению урожая хлопчатника. Мульчирование оказалось также хорошим контролёром над сорняками и на замульчированном участке требовалась лишь незначительная культивация.

ЗАДЕРЖКА РОСТА СТЕБЛЯ СЕЯНЦЕВ ГРУШИ С ПОМОЩЬЮ ССС (2-ХЛОРЕТИЛ-ТРИМЕТИЛАММОНИЙХЛОРИД)

Д. ШУРАНИ

Проводилась обработка сеянцев дикой груши хлористым (2-хлорэтил) триметиламмонием при концентрации 10^{-4}, 10^{-3} и 10^{-2} М. Каждый сеянец получил путем орошения 120 мл раствора ССС или водопроводной воды. ССС при концентрации 10^{-2} М достоверно задерживал удлинение стебля. При обработках раствором ССС при концентрации 10^{-3} и 10^{-4} М задерживающее влияние оказалось временным, более того при обработке концентрацией 10^{-4} М оно даже не проявилось.

ГЕНЕТИЧЕСКИЙ АНАЛИЗ *T. AESTIVO-TIMOPHEEVI* АМФИДИПЛОИДА

А. БЕЛЕА

Нами проводится генетический анализ амфидиплоида, полученного путем обработки колхицином F_1 межвидовых гибридов ***T. aestivum*** L. (ABD) и ***T. timopheevi*** Zhuk (AG), а также и его позднейших поколений. Определенная связь родства между 2 видами была выявлена в результате выщепления разных типов в F_2—F_3. Встречались растения, имеющие $2n = 70$ и $2n = 56$ хромосом. Кроме способности выщепившихся растений к скрещиванию и фертильности изучались также их квантитативные и квалитативные свойства и признаки.

ИССЛЕДОВАНИЯ ПО ТЕХНОЛОГИИ ЛЮЦЕРНЫ: СУШКА ГОРЯЧИМ ВОЗДУХОМ С УЧЁТОМ КОНСЕРВАЦИИ И СТАБИЛИЗАЦИИ КАРОТИНА

З. КИНФФИ, М. ФАРҚАШ

Эксперименты были выполнены для того, чтобы уменьшить себестоимость люцерны, высушенной горячим воздухом, действие которого оказалось эффективным.

Желательно сушить зелёную люцерну на лугу после уборки при влажности 68—70 процентов, потому что в этом случае можно сэкономить 15 кг горючего на каждые два центнера люцернового сена. В это же время потеря протеина и каротина очень незначительна.

Результаты экспериментов по устойчивости каротина доказали, что в интересах уменьшения потерь каротина наиболее практично непосредственно после сушки обработать материал антиоксидантом и после этого делать из него брикеты с соответствующим уплотнением. Однако материал после сушки, в случае брикетирования, размалывать излишне. Достаточно делать брикеты из мелко раскрошенного высушенного материала. В этом случае в значительной степени повышается специфическая ценность конечного продукта, необходимо будет меньшее количество складов, транспортировка будет легче и содержание каротина может продолжительное время сохраняться лишь с незначительной потерей его в течение этого времени. Стоимость продукта можно также уменьшить с помощью правильного регулирования испарения воды. Достаточно сушить зелёную люцерну до тех пор, пока содержание сухого вещества не составит 88—90 процентов.

ЭКСПЕРИМЕНТ С НЕПРОРЕЖЕННОЙ КУЛЬТУРОЙ МАКА, ВЫРОСШЕГО ИЗ ОБЛУЧЁННОЙ СМЕСИ СЕМЯН

П. ТЭТЭНИ, Д. ФЁЛЬДЯШИ

Используя частично облучённую смесь семян в экспериментах на маленьких участках и в опытах больших масштабов в течение 4-х лет получали надёжное прорастание семян. Посев неповреждёнными семенами при норме 40 дкг на кадастральный хольд дал совершенный травостой. Растения могли быть одинаково прорежены с расстоянием друг от друга в 10 см даже и тогда, когда рабочей силы, обычно используемой в этих случаях, было, в среднем, на 50 процентов меньше.

Растения, выращеные из облучённой смеси семян, находящиеся вначале на лучшем расстоянии друг от друга, показали лучшее развитие. Они давали коробочки и семена такого же качества, как и растения, выращенные по настоящей методике. Эксперименты на маленьких участках доказали, что при посеве неповреждёнными семенами с нормой высева 30—40 дкг на кадастральный хольд (300 000—600 000 проростков на кадастральный хольд) можно получать урожай равный урожаю, получаемому при прореженной культуре, хотя в данном случае прореживание и не проводится.

ВЛИЯНИЕ НЕДОСТАТКА КАЛЬЦИЯ И СЕРЫ НА ОБМЕН САХАРА У РАСТЕНИЙ *LINUM USITATISSIMUM* LINN.

Р. К. ШРИВАШТАВА, ШРИ РАНЬЯН

Открытие авторов показывает, что недостаток кальция и серы вызывает изменение в метаболизме семенных растений льна, что видно из более высокого накопления сахаров в органах, лишённых минеральных веществ, при сравнении их с соответствующим контролем.

СЕЗОННЫЕ ИЗМЕНЕНИЯ АКТИВНОСТИ КАТАЛАЗЫ У КОРНЕСОБСТВЕННЫХ ЯБЛОНЬ ШТАММА ЕМ—IV И СОРТА STARKING

Й. САЛАИ

Для изучения сезонных изменений активности каталазы у корнесобственных яблонь штамма ЕМ—IV и сорта Starking был использован метод проф. Френьо. Эти два сорта яблонь показали различную активность каталазы в течение вегетационного периода.

Различия между нижними и верхними листьями ствола яблони штамма ЕМ—IV так же как и различия между средними и верхними листьями сорта Starking были существенны, уровень вероятности $P = 10\%$. Активность каталазы у изученных сортов яблонь изменялась в течение вегетационного периода и различия, обнаруженные в отдельные фазы, были существенны, уровень вероятности соответственно по фазам равнялся $P = 5\%$, $P = 1\%$, $P = 0{,}1\%$.

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XYLOTOMIC STUDIES ON VINE

By

Á. HEGEDÜS

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Tissue structure of several years old wood in 16 cultivars of *Vitis vinifera* and 1 cultivar of each of *V. labrusca* and *V. riparia* originating from 5 Hungarian and 2 foreign sites has been examined and the dimensions of the various components measured. While there is no fundamental difference in structure, significant differences in dimensions have been found between the samples. These differences are partly of varietal origin and partly due to the different ecological conditions of the individual growing sites. Further investigations are required to find out to what extent thes. two factors act.

Introduction

Xylotomy performing detailed studies on several years old wood reaches back to more than hundred years, still there are relatively few data available on the xylotomy of one of our most important woody cultivated plants: vine. Its main reason is that xylotomists have been interested primarily in industrially utilizable woods and only incidentally dealt with plants less important from the point of view of wood industry, e.g. vine. And even those dealing with the anatomy of vine studied mostly the structure of the one-year-old cane; and though its wood structure is essentially identical with the structure of the several years old wood, special study of the latter is not superfluous.

The first data on the xylotomy of vine *(V. vinifera)* were presented by SANIO (1863) who included this plant in his taxonomic key. This work mentions the following cell types of vine wood: wood parenchyma, simple and septate xylem fibres, vessels and tracheids. There are two kinds of vessels, and tracheids differ from small-diameter vessels in being not perforated. SCHMIDT (1941) too wrote about the vine. According to his description it is characterized by the presence of vessels with large diameters, a ring-porous structure of the growth-ring (though the author notes that often it is not along the boundary of the growth-ring that the largest vessels are found). The late wood is characterized by radial groups of small vessels. The walls of the vessels are of scalariform, while those of the small-diameter vessels are often spirally thickened. Tyloses frequently occur. Wood parenchyma is sporadical, paratracheal. Medullary rays are somewhat heterogeneous, very wide and high, and raphide

Table 1

Dimensions of xylem elements in the old wood of various vine cultivars and species

Site	Cultivar	Age Year	Dimensions of vessel elements, (micron)						Dimensions of wood fibres, (micron)						Dimensions of wood parenchyma cells (micron)		
			width			length			width			length					
			max.	min.	large ves. average	max.	min.	average	max.	min.	average	max.	min.	average	radial	tangential	axial
Katona-telep	Malakoff izjum	6	283	8×12	237	650	176	514	32	12	18	989	432	719	10—25	14—32	17—63
	Mézes fehér	7	331	7×25	248	745	268	580	31	13	22	1002	280	699	18—25	14—35	18—53
	Ida	18	297	7×18	247	738	315	582	32	13	18	1075	309	635	20—28	20—35	25—52
	Charmand rouge	3	226	11×17	186	674	320	507	30	12	20	955	396	636	17—35	21—35	20—116
	Bernáth János	12	339	7×17	271	742	282	567	23	10	18	1043	390	665	12—42	10—32	17—70
Tarcal	Furmint	12	252	7×12	230	756	167	400	36	9	24	1087	391	747	18—25	11—25	14—60
Eger	Mézes fehér	7	246	4×18	201	580	263	464	25	11	19	921	273	613	14—25	14—25	21—63
	Leányka	8	199	9×21	167	702	198	470	29	10	18	891	386	635	14—35	14—32	21—70
	Olaszrizling	6	255	11×21	199	741	204	567	30	13	23	1086	452	760	14—25	10—28	14—70
	Medoc noir	5	220	7×17	157	635	264	497	31	10	20	923	242	625	17—35	12—24	20—70
	Kékfrankos	3	223	5×11	193	608	345	565	34	12	22	892	302	609	14—30	14—35	17—106
Budapest	Szürkebarát	8	321	7×17	218	593	282	472	23	12	17	930	335	624	11—25	14—28	35—70
	Hárslevelű	9	255	6×12	200	635	170	419	28	14	21	1006	429	691	14—28	14—28	35—42
	Piros szultán	8	349	9×18	252	700	285	518	27	14	19	858	309	548	10—35	14—25	35—60
	Piros tramini	10	260	6×18	217	627	292	454	25	14	19	925	448	650	17—21	14—21	28—70
Asti	Barbara	35	273	6×17	203	526	166	343	24	11	17	844	447	638	10—14	14—17	17—47
Taskent	Basarabi	6	420	8×18	336	730	218	511	28	11	20	1091	424	793	10—14	14—21	25—70
Miklós-telep	Izabella	33	320	6×20	279	726	429	584	36	9	21	1118	359	702	17—35	14—35	38—123
	Portalis	25	327	8×17	269	729	192	507	32	12	23	1027	567	812	12—35	9—35	35—141
	l.s.d. 5%				11			48			2			75			

Continued from Table 1

Site	Cultivar	Dimensions of ray cells (micron)															Number of cell-rows in the medullary ray			Height of medullary ray (micron)	Number of medullary ray per mm
		radial						tangential						axial							
		early wood			late wood			early wood			late wood										
		max	min.	average	max.	min.	average	max.	min.	average	max.	min.	average	max.	min.	average	max.	min.	average		
Katona-telep	Malakoff izjum	104	72	85	35	19	28	30	16	22	23	18	21	28	16	22	15	5	9.4	1111—∞	3.16
	Mézes fehér	80	51	67	26	17	22	23	17	20	21	17	18	32	15	22	17	2	9.6	350—∞	2.41
	Ida	99	84	93	18	12	15	21	16	18	18	13	16	29	13	21	18	3	9.6	410—∞	2.41
	Charmand rouge	132	102	112	21	15	18	25	16	19	26	16	19	29	15	21	13	3	8.4	847—∞	3.10
	Bernáth János	100	70	89	23	15	19	23	16	20	18	15	17	17	15	22	16	4	10.8	175—∞	2.84
Tarcal	Furmint	98	80	88	22	14	17	22	18	20	19	16	17	27	10	17	12	2	7.5	350—4970	3.00
Eger	Mézes fehér	98	75	88	21	12	17	29	18	22	17	13	16	26	13	19	13	3	8.6	1130—∞	3.08
	Leányka	86	74	73	25	18	21	34	17	25	19	15	17	33	14	23	14	3	6.9	351—∞	3.16
	Olaszrizling	88	68	81	25	16	18	21	17	19	19	12	12	24	10	18	13	5	9.2	234—∞	3.42
	Medoc noir	95	68	80	26	17	21	25	17	19	21	16	18	34	12	23	12	1	7.9	1340—∞	3.91
	Kékfrankos	119	73	88	22	14	18	26	15	18	20	14	17	31	14	20	9	1	6.1	1200—∞	3.48
Budapest	Szürkebarát	101	74	88	33	19	24	24	16	20	21	11	16	25	13	18	14	2	8.8	∞	3.05
	Hárslevelű	100	72	85	34	19	26	30	15	20	21	11	18	29	15	22	13	2	7.3	1200—∞	3.00
	Piros szultán	103	67	82	37	22	27	29	18	24	21	15	19	28	13	21	13	4	8.7	820—∞	3.26
	Piros tramini	99	79	88	34	19	25	27	15	21	24	15	20	28	16	22	13	2	8.9	1232—∞	3.00
Asti	Barbara	107	85	92	24	14	18	25	16	20	19	14	17	27	15	21	21	5	12.7	205—2632	2.30
Taskent	Basarabi	145	101	120	20	12	16	26	17	22	25	16	19	31	11	21	12	3	7.7	1755—∞	2.62
Miklós-telep	Isabella	122	87	105	25	18	20	24	16	20	19	16	17	27	11	16	16	4	11.3	3000—∞	2.78
	Portalis	88	70	78	23	15	18	18	14	16	20	16	18	25	10	17	10	2	6.3	133—9240	3.16
	l.s.d. 5%			8			3			3			2			4			1.7		0.30

bundles are often found in them. The most detailed description of vine wood is given by GREGUSS (1945). The characteristic data are contained in the taxonomic key, the detailed description and the Table. There is no possibility to repeat here the very precise descriptions, only statements to be discussed or contradictory to the data of other authors will be presented here. According to the taxonomic key the vessel clusters form a well distinguished ring of holes, while the description speaks of diffuse porous structure, just as it is shown also by the Table. The small holes arranged radially in the late wood are joined by quite a number of tracheids, while according to the Table there are no tracheids. The basic substance is a mass of xylem fibres. The height of the medullary ray may be several cm. In the radial section ray cells are lying parallelepipeds, but at the boundary of the growth-ring shorten and may become standing parallelepipeds. On the other hand, according to the Table the medullary rays are homogeneous, their number is 8 per 1 mm (in Schmidt's work less than 4), supplementary fibres are missing, paratracheal and metatracheal parenchymae equally occur.

According to earlier investigations of our own (HEGEDŰS 1964, 1966, 1967) the growth-ring is rather diffuse porous. The basic substance of the wood consists of septate fibres with undivided supplementary fibres among them. There is a small amount of paratracheal parenchyma. Medullary rays are not completely homogeneous but not decidedly heterogeneous either.

In the course of our recent investigations we tried to find out whether there were any xylotomic differences between the grapevine *(V. vinifera)* varieties and whether they differed from other *Vitis* species.

Materials and Methods

Since obtaining old woody parts of vine suitable for xylotomic examinations is not an easy task, we could not perform systematic comparative studies with identical varieties originating from different sites, and had to be satisfied with the available samples. Only node-free discs excised from several years old trunks or arms of trellised vines are suitable for such examinations. We collected the following samples: 14 cultivars of *V. vinifera* from 4 sites of Hungary, 1 cultivar of each of an Italian and Uzbek site, and, finally, two other *Vitis* species (*V. labrusca* and *V. riparia*) from a Hungarian site. Names and sites of varieties as well as the age of the examined wood parts are shown in Table 1. There was only one variety obtained from two sites.

We made cross-, tangential- and radial sections as well as macerates of all samples and performed examinations and measurements with them. Diameters of vessels, radial and tangential dimensions of ray cells as well as width and number per mm of rays were determined in the cross sections. Length of vessel elements, tangential and axial dimensions of wood parenchyma cells, axial dimensions of ray cells as well as the height of the rays were measured in tangential longitudinal sections. Width and length of xylem fibres and length of a part of the vessel elements were measured in the macerates. The number of measurements taken from the vessel elements per variety was 30—40, from ray cells, and concerning the width and number of rays, it was 20, and from fibres 30—180. As for the wood parenchyma cells only extreme values of dimensions were determined, since their shapes were greatly influenced by the adjacent vessels and because no significant differences were observed between the varieties; similarly, only dimension limits are given for the height of the medullary rays. In relation with the latter ∞ means that height exceeds 10 mm.

The examinations were performed on the external, youngest part of all samples; in 3—8 years old vines the outermost 1—2, while in older ones 1—3 growth-rings were studied; only in the wood macerate of the variety Isabella were the fibre dimensions of the outermost 1—3 and the inner 20—25 growth-rings separately examined.

Results

The characteristic wood structure of *V. vinifera* was found in all samples (Figs 1—8). In this respect the *V. labrusca* (Isabella) and *V. riparia* (Portalis) samples were not different either. Widths of growth-rings are highly varying. Even within the same growth-ring the widest place is usually the multiple of the narrowest one. In our measurements 120 and 4415 μ are the extreme values of width of growth-rings. The growth-ring is usually divided into a wide early and a narrow late wood. The early wood is diffuse porous, while in the late wood small diameter vessels of oblong cross section are found in radial rows. In most cases these rows reach the boundary of the growth-ring and the vessels in them decrease in diameter while approaching the boundary. Tangential dimensions of the vessels decrease to a lower while radial ones to a higher extent; thus tracheae of 4—11 μ radial and 11—25 μ tangential diameter are found at the boundary of the growth-ring. These are described by the authors cited as having also tracheids among them. It is a question extremely difficult to decide on, since the perforation is generally found on the radial wall being very narrow in the vessels of the late wood, the perforation is — of course — also very small and difficult to detect. In maceration it is impossible to recognise the perforation, as the elements lay on their flat tangential sides while the perforation being on the perpendicular wall, cannot be seen. In a radial longitudinal section, on the other hand, perforation was found in the narrowest component as well, which suggests that it is present even where we have not managed to recognise it. On this basis we think that there are no tracheids in the xylem of the *V. vinifera* and related species. In the course of our examinations described above no ladder-like perforation was found which shows that this type of perforation is very rare in vine and in the several years old wood it may even be totally absent. We have found growth-rings with late wood entirely missing in them and also a narrow growth-ring consisting of late wood alone.

The largest trachea diameter (420 μ) was measured in a *V. vinifera* sample originating from the irrigated area of Taskent. The average diameter size of the large vessels (pores) ranged from 157 to 336 μ (l.s.d.: 11 μ). As vessel diameters of "Mézesfehér" samples originating from two sites were also significantly different, we concluded that this feature is determined by ecological conditions rather than by the variety or species. Vessel diameters are largest in samples originating from the irrigated areas of Taskent as well as from drift-sand areas (Katonatelep, Miklóstelep), while smallest in those

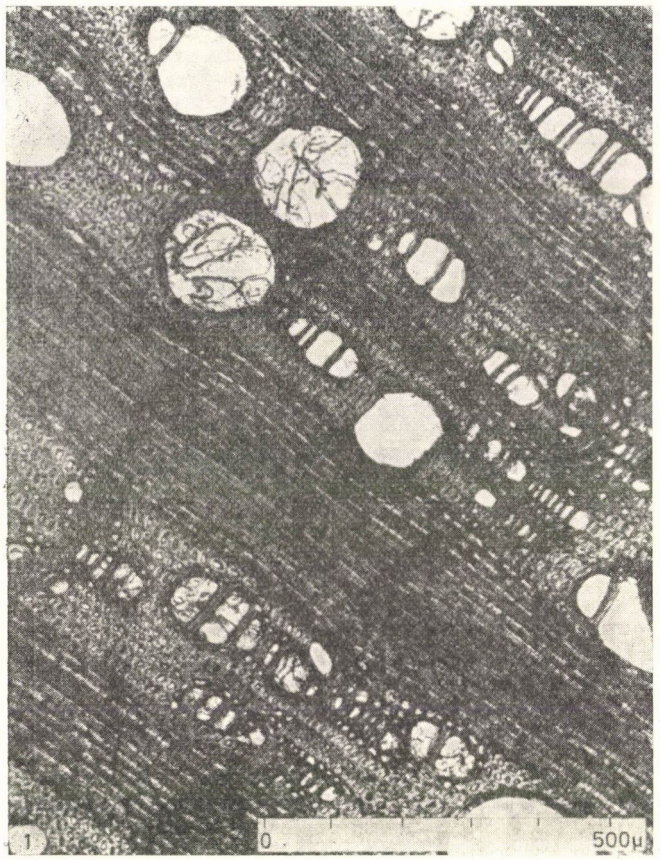

Fig. 1. "Bernáth János" cross section. Two growth-ring boundaries with a very narrow growth-ring between, in which the early wood is almost entirely missing. Radial vessel rows (pore-rays), in certain vessels tylose formation

originating from clay soils of Eger, and in the Northern Italian (Asti) samples whose site conditions are, however, hardly known.

The highest variability in the length of the vessel elements (167—756 μ) was observed in the "Furmint" sample of Tarcal, but the means ranged only from 343 to 584 μ (l.s.d.: 48 μ). Comparison of the data of the individual varieties shows that samples with smaller vessel diameters are characterized also by shorter elements. Certainly, the samples obtained from Katonatelep, Miklóstelep and Taskent were characterized by longer elements. Relationship between the width and length of elements of the same sample was examined too. In the "Mézesfehér" sample of Katonatelep 20 of each of the fibre-like, transitional and broad vessel elements were measured and the following data obtained:

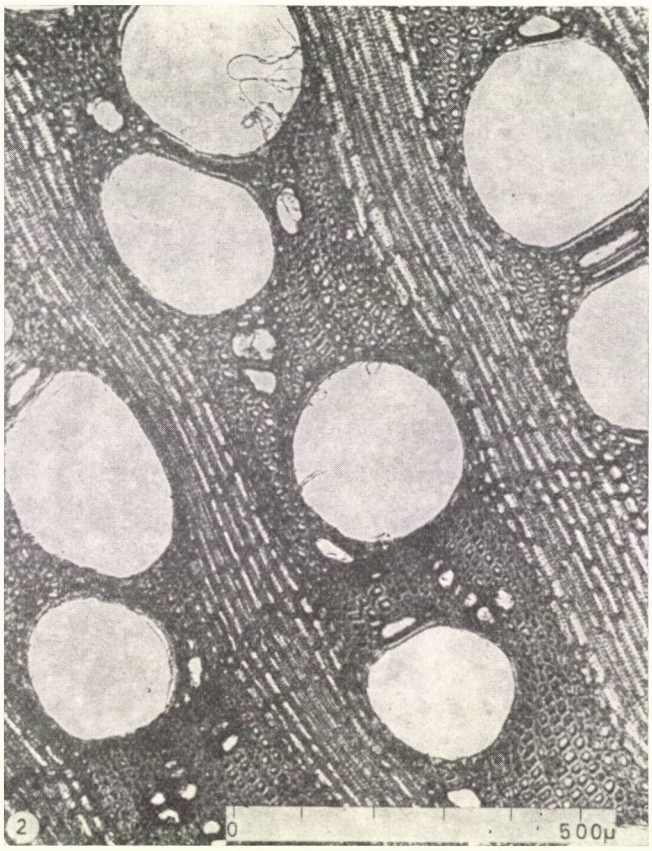

Fig. 2. "Basarabi" cross section. Very wide vessels. Short ray cells are clearly seen in the late wood. In one of the vessels some tyloses

average length of 12—49 μ wide fibre-like vessel elements	560 μ
average length of 50—99 μ wide transitional vessel elements	448 μ
average length of 100—199 μ wide broad vessel elements	492 μ

Fibre-like vessel elements were the longest and the transitional ones the shortest of all, but the differences were not as great as in other woody plants. Vessels in the heartwood are characteristically blocked with tyloses while in the sapwood this phenomenon is normally sporadical, and its mass occurrence is a pathological symptom. In certain vessels of the vine so called intracellular bars are present (Fig. 3) which radially traverse the vessel. Their mass occurrence is considered to be a virus symptom.

The basic substance of wood does not in fact consist of real xylem fibres but of septate fibres divided by transversal walls; however, due to their containing living protoplasm they are considered as supplementary fibres. This opinion is confirmed by the fact that towards the wood parenchyma transitional

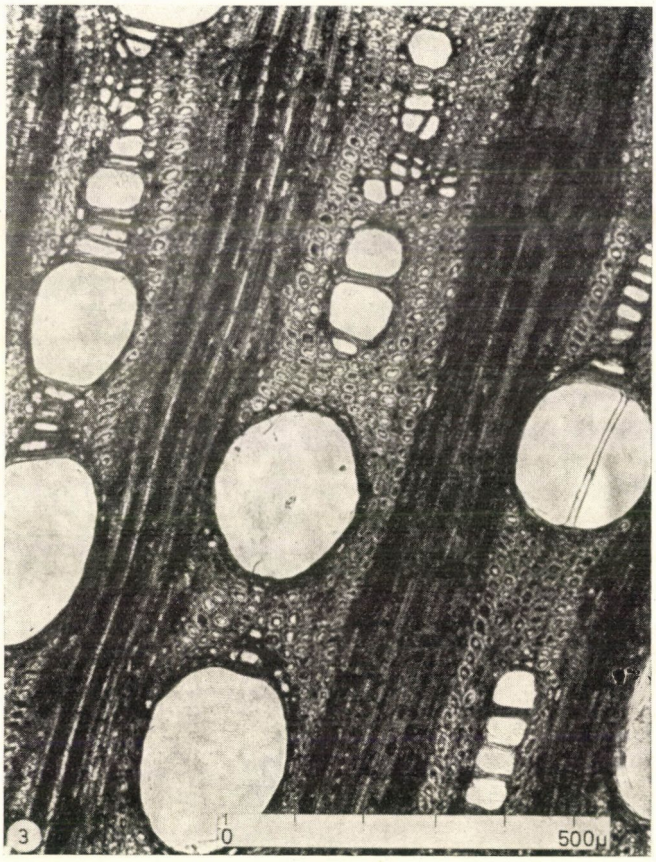

Fig. 3. "Isabella" cross section. Pore-rays. In one of the vessels intracellular bar

types also occur. For practical reasons, however, we continue to call them wood fibres. The wood fibres are 17—24 μ wide on the average (l.s.d.: 2 μ), but without any regularity found in the change of width, and 273—1118 μ long, with an average length of 609—812 μ (l.s.d.: 75 μ). It is remarkable that the longest fibres are found in the wood of *V. riparia*, but as this fibre length does not significantly differ from those of several *vinifera* varieties, it cannot be considered a feature characteristic of the species. In some varieties (Furmint, Medoc noir, Kékfrankos) fibre dimensions of several samples obtained from the same site were examined but no significant intravarietal difference was found among them. In the Isabella strain of Miklóstelep fibre dimensions of the outer younger and inner older wood were examined. According to the tentative examinations inner older wood fibres were both wider (22 μ) and longer (719 μ) than that in the outer younger part (20 and 686 μ respectively). This difference is significant for the width but not for the length. Wood

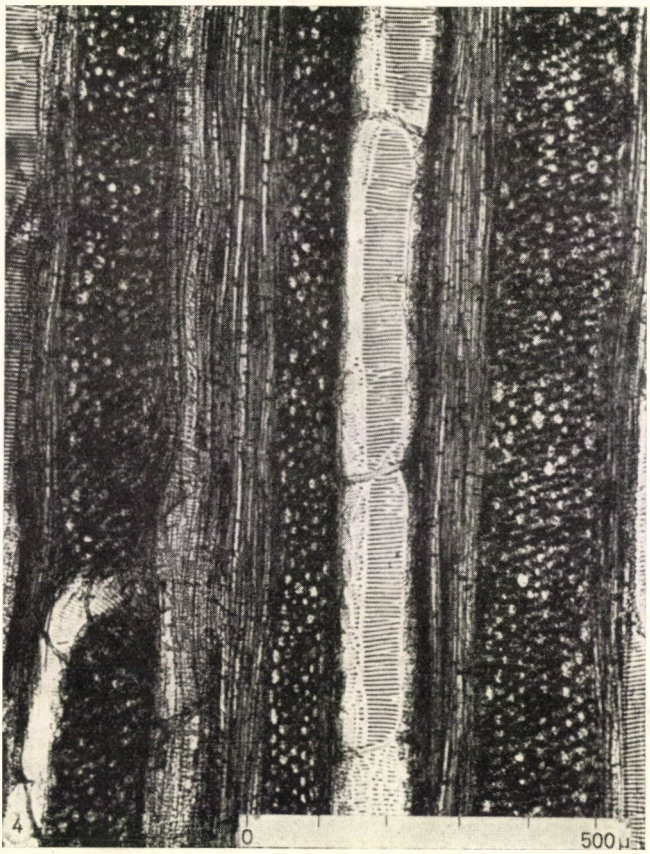

Fig. 4. "Szürkebarát" tangential longitudinal section. The wide medullary rays seem to be groups of round cells. On the left a vessel is seen as transversing the medullary ray. The wide ladder-like pit-pattern of vessels on the left and in the middle suggests the presence of two adjacent vessels

parenchyma occurs exclusively directly beside the vessels, and thus has a paratracheal position. Its shape is determined by the adjacent vessel. Radial and tangential dimensions of parenchyma cells — ranging between 9 and 42 μ — are largely the same. Their axial measurements range from 14 to 141 μ; here some varietal differences may be observed. The upper values are lower in the vinifera varieties than in others (Isabella, Portalis).

Vine xylem is characterized by wide and high medullary rays. 9— 21 is the highest, 1—5 the lowest width in cell rows of the rays, 6.1—12.7 cell rows on the average (l.s.d.: 1.7 cell rows). Barbara, Isabella and Bernáth János excel in wide, Kékfrankos, Portalis and Leányka in narrow rays. Older samples seem to have wider rays but not in every case; site of origin too has undoubtedly some influence on this property, as it is shown by the narrow medullary rays

Fig. 5. "Szürkebarát" tangential longitudinal section. Medullary rays, vessels, septate fibres and wood parenchyma can be seen

of the Eger and Taskent samples; further, it may also be a varietal (species) character, as in the case of the narrow medullary rays of Portalis. When comparing the width of the medullary ray to that of the inter-xylem, Szürkebarát with rays much narrower (which is, however, not adequately seen in the photos made for some other purpose) and Barbara with ones somewhat wider than the inter-xylem are varieties of extreme position. Medullary rays are far less high than in old woods in the one-year old cane, where they may extend to several internodes, thus their height can be expressed in decimeters. In old wood such high medullary rays are not present any longer, since secondary rays become lower and lower, on the one hand, and adjacent woods are transversally joined together and medullary rays thus divided into lower sections, on the other. During our present investigations medullary rays lower than 1 mm were found in more than fifty per cent of the samples, and there was only one sample (Szürkebarát) in which no medullary ray lower than 10 mm was found. There

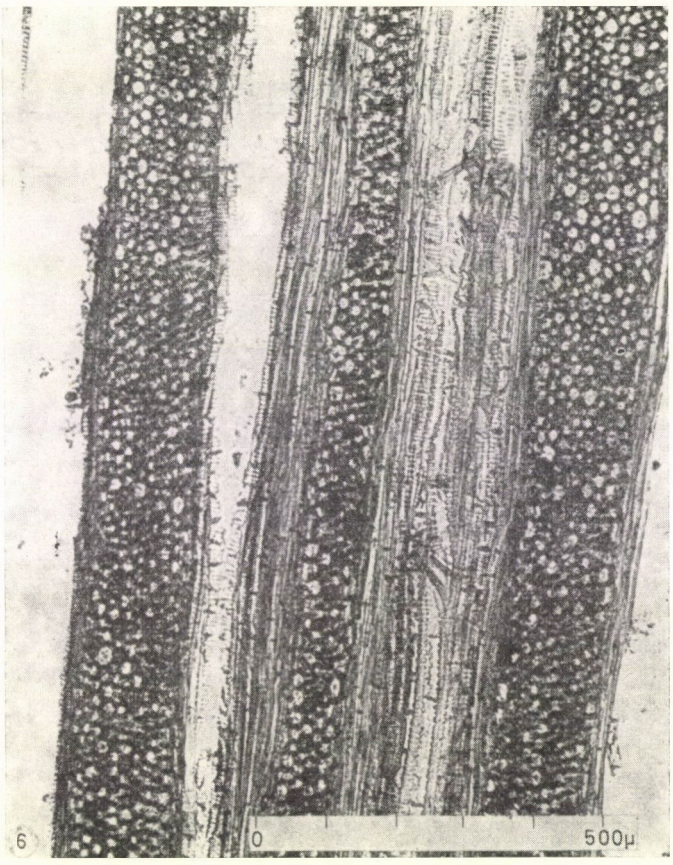

Fig. 6. "Szürkebarát" tangential longitudinal section

were three samples in which the uppermost value of ray height did not reach 10 mm. Height trends of medullary rays are probably influenced by differences in the varieties apart from the age of the vine. Number per mm of medullary rays is 2.30—3.91 (l.s.d.: 0.30). This value is largely in inverse proportion with the width of the medullary rays. Ray cells have generally the shape of a lying prism (their radial dimension is the largest), but in the late wood, especially in the direct neighbourhood of the growth-ring boundary, they become considerably shorter in as much as their heights (axial dimensions) often exceed their radial dimensions, thus the cells are of standing position. The heterogeneous structure of medullary rays is emphasized also by the presence of raphide idioblasts. These are generally characteristic of the medullary rays of vine, though during our investigations they were not found in the varieties Charmand rouge, Leányka, Medoc noir and Szürkebarát, and were found only at the edges of medullary rays in the varieties Olaszrizling, Basarabi and Portalis. In other varieties they are more or less frequent in the medullary

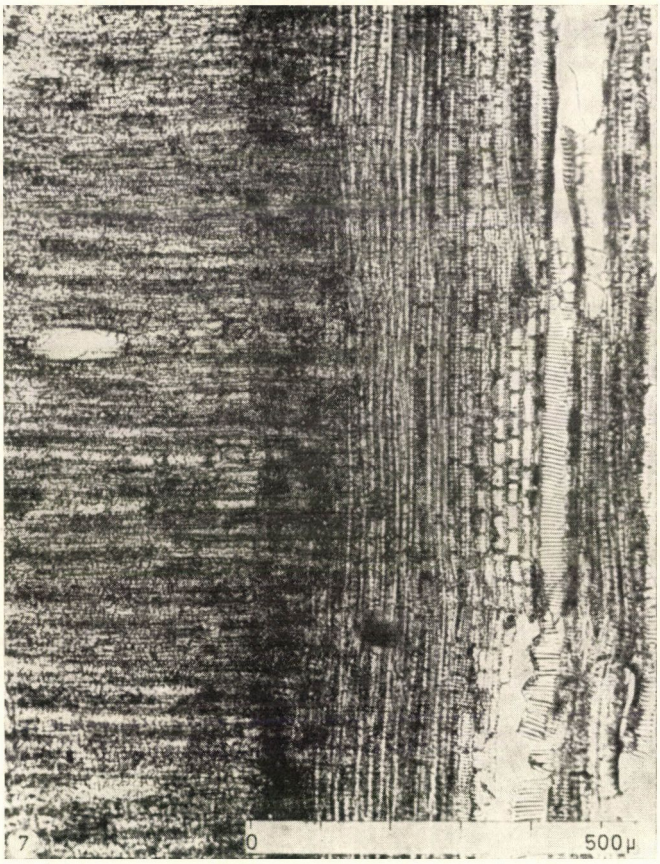

Fig. 7. "Furmint" radial longitudinal section. On the left a medullary ray with a raphide idioblast in it (raphids fell out when the section was made). On the right: tracheae, wood parenchyma and septate fibres

rays. The raphide-holders have also a radially lying position, 70—176 μ (an average of 116 μ) radial, 25—70 (an average of 44) μ tangential and 25—70 (an average of 44) μ axial dimensions; thus the two latter dimensions are nearly the same. Radial dimensions of normal ray cells are 67—120 μ in the early wood, 15—28 μ in the late wood; tangential dimensions are 16—24 μ in the early wood and 16—21 μ in the late wood; and axial dimension (height) is 16—23 μ. In the early wood the tangential dimension too is generally somewhat larger than in the late wood (with the exception of Portalis). Tangential and axial dimensions of ray cells are largely the same. Raphide-holders exceed normal ray cells primarily in tangential and axial dimensions, but in most cases in radial dimension too. All these suggest that the medullary ray of the vine is not of entirely homogeneous structure, but cannot be considered as typically heterogeneous either.

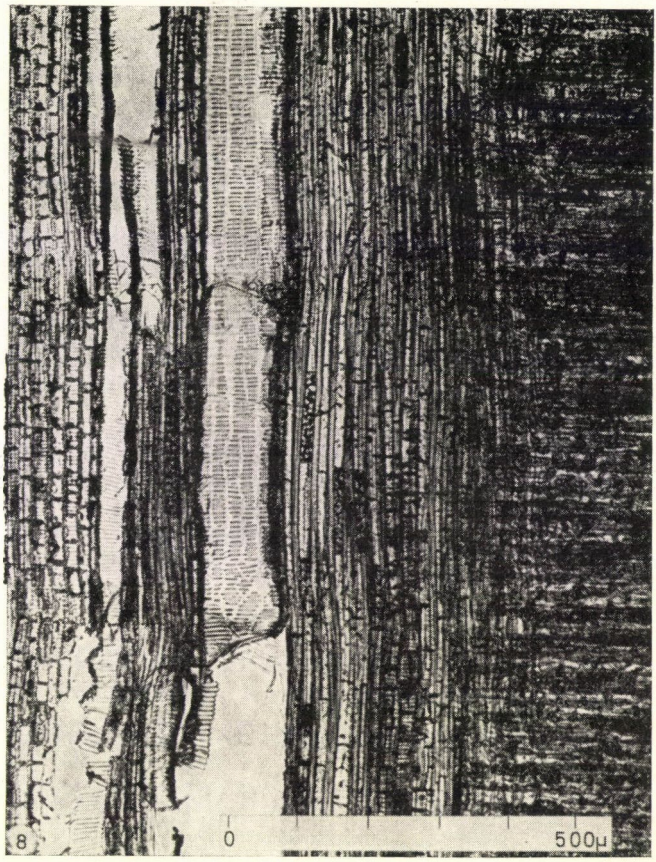

Fig. 8. "Furmint" radial longitudinal section. On the right: medullary ray; on the left: wood parenchyma, vessels and septate fibres. From the pattern of the pits of the large vessel it can be seen that here the vessel is adjacent to wood parenchyma cells

Results and Discussion

Wood structure of the several years old vine (which is the subject of xylotomy) for the main features corresponds to that of the one year old cane. The major differences are: in the second and subsequent years unevenness in structure of the wood originating from dorsiventrality of the cane gradually disappears. On the flat and canaled side of the cane a low number of vessels with small diameters, while on the dorsal and ventral sides a considerable number of vessels with large diameters are found in the wood (HEGEDÜS 1960). Growth-rings are not uniformly wide in the subsequent years either (HEGEDÜS 1964), but this unevenness is influenced by pruning to a high extent, and distribution of vessels is more or less uniform. The relative quantity

of fibres decreased in the wood during the following years, and vessel-free wood similar to that of the one-year-old cane was not found.

According to METCALFE's classification (1950) majority of the samples contain vessels with small, medium and large diameters; large vessels are absent only in the sample of Leányka. Average fibre length does not exceed the length of short fibres (900 μ).

One of the most interesting question concerning the wood structure of vine is the presence or absence of tracheids. SANIO (1863) pointed out that tracheids differ from small diameter vessels only in being not perforated. According to GREGUSS' description (1945) there are many tracheids in the late wood but his table does not show any. The difficulties of clarifying this question have already been pointed out. Therefore, though we have not managed to find perforation in each water-transporting element examined, in our opinion there are no tracheids in the wood of the vine.

According to SCHMIDT (1941) pores in the growth-ring are arranged in a ring, though often the largest vessel diameters are not found along the boundary of the growth-ring. In GREGUSS' (1945) taxonomic key the growth-ring is ring-porous, while both in his detailed description and table it is diffuse-porous. According to HEGEDÜS (1964, 1966, 1967) growth-rings are diffuse-porous. Our present investigations have confirmed the latter opinion. The growth-ring is generally diffuse-porous, only sometimes, when the growth-ring consists of a narrow early and relatively wide late wood seems it to be ring-porous.

According to Schmidt and Hegedüs vine wood is characterized by a low amount of paratracheal parenchyma. Greguss describes a fairly frequent occurrence of parenchyma cells among the xylem fibres and joined to the vessels; his table shows the presence of both paratracheal and metatracheal parenchymae. Our present investigations have proved Schmidt's and Hegedüs' statements correct, that is, wood parenchyma occurs only in the closest vicinity of vessels.

The height of the medullary rays is described as 1—5 mm by Schmidt, as several mm by Greguss' taxonomic key, and as several cm by his detailed description. Hegedüs considers the medullary rays to be several mm high. According to our present investigations many-cm height of the medullary ray in several years old wood is an overestimate. In the majority of the samples medullary rays lower than 1 mm and higher than 10 mm equally occur.

As to the homogeneity of rays there are not serious contradictions. Schmidt describes them as slightly heterogeneous. In Greguss' description ray cells mostly have a lying position, though near the boundary of the growth-ring they may be of standing position as well, and in his table medullary rays are shown as homogeneous. Hegedüs considers them as not quite homogeneous and not definitely heterogeneous either. There is no doubt that some hetero-

geneity in the structure of the medullary ray can be observed, but it is not as marked as in those woody plant species for which this term was created.

In Greguss' Table the number of medullary rays per mm is 8, in Schmidt's work less than 4, while in our own investigations we have found them to agree with Schmidt's data, that is to be 2.30—3.91.

The difficulty of qualifying xylem fibres lays in fibre-like components of wood being not classified quite consequently. If Sanio's definition of wood fibre being a lifeless component filled with air is accepted, the fibre-like component of vine wood cannot be considered as true xylem fibre, since it contains living protoplasm. On the other hand, in Sanio's work the supplementary fibre is a living fibre-like element. But the supplementary fibre concerning its wall structure is a transition to the wood parenchyma. Such components can be found in vine wood too, but the typical septate fibre is not like that. The typical septate fibre of the vine has a thick wall with or without a tiny tertiary spiral thickening on the inner side and very narrow slit-like pits. Supplementary fibres have somewhat larger diameters and large pits on their walls (similarly to the wood parenchyma). Therefore in our opinion Sanio's definition should be rejected and wood fibre be determined as follows: wood fibre is an elongated, thick-walled living or lifeless element sharpened at the ends, with very narrow slit-like pits on its wall. Thus, wood fibre of the vine can be called a living septate wood fibre without any difficulty.

As for the dimensional differences in the structure of the wood it was found that in all dimensions examined there were significant differences between the samples. Since the varieties collected from different sites were not identical it could not be mathematically proved whether it was variety or site that primarily caused the differences. The fact, however, that the two "Mézesfehér" samples originating from two sites differed in 8 dimensions significantly and only in 3 (tangential dimension of ray cell in the early wood, axial dimension of ray cell and width of medullary ray) non-significantly, suggests that it is the ecological factors that primarily determine the dimensional differences. The two non-vinifera varieties: *V. labrusca* (Isabella) and *V. riparia* (Portalis) do not differ from the other samples to a higher extent than the other samples differ from each other, that is, no feature showing definite differences between the species could be found. Thus we can draw the conclusion that concerning the structure of the several years old xylem *V. vinifera* does not differ from the closely related species examined.

REFERENCES

GREGUSS, P. (1945): A közép-európai lomblevelű fák és cserjék meghatározása szövettani alapon (Histological determination of deciduous trees and bushes in Central Europe). Természettudományi Múzeum, Budapest.

HEGEDÜS, Á. (1960): Előmunkálatok a szőlő alanyfajták egyéves vesszőjének szövettani úton való megkülönböztetésére (Preparatory work for the histological distinction of one-year old canes of vine stock varieties). Kísérleti Közlemények, **53,** 23—43.

HEGEDÜS, Á. (1964): A szőlőnövény anatómiai felépítése (Anatomical structure of vine). In KOZMA: Szőlőtermesztés (Viticulture) I. 98—139.

HEGEDÜS, Á. (1966): A szőlő belső alaktana (Inner morphology of vine). In HEGEDÜS—KOZMA —NÉMETH: A szőlő (Magyarország kultúrflórája)[Vine (Cultivated plants of Hungary)]. 60—99.

HEGEDÜS, Á. (1967): A szőlő anatómiai felépítése (Anatomical structure of vine). In KOZMA: Szőlőtermesztés (Viticulture). I, 2. edition 123—170.

METCALFE, C. R.—CHALK, L. (1950): Anatomy of the dicotyledons I—II. Clarendon, Oxford.

SANIO, C. (1863): Vergleichende Untersuchungen über die Zusammensetzung des Holzkörpers. IV. Bot. Ztg., **21,** 401—412.

SCHMIDT, E. (1941): Mikrophotographischer Atlas der mitteleuropäischen Hölzer. Neumann, Neudamm.

Acta Agronomica Academiae Scientiarum Hungaricae, Tomus 19 (1—2), pp. 17—23 (1970)

POLLEN PRODUCTION AND ANTHER EXTRUSION OF WHEAT (TRITICUM AESTIVUM L. EM THELL.)

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A good pollinator in hybrid wheat production, besides favourable combining ability and fertility restoration properties, should possess high pollen productivity and ability to extrude anthers. Efficiency of pollen production and speed and intensity of anther extrusion was studied in 26 varieties in 1968 and 1969. The varieties significantly differed in: per cent and speed of anthers extruded, size of anthers, and in number of pollen grains/anther. Correlation coefficient between anther length and number of pollen grains/anther amounts to 0.87 and between anther width and number of pollen grains/anther 0.54. On selecting genotypes with larger anthers, production of pollen grains per anther increases.

There is a significant positive correlation between length of vegetation and anther length ($n = 0.57$); but not between length of vegetation and width of anthers ($n = 0.13$). We could not find correlation between per cent of anthers extruded and other characters studied.

The results obtained might be useful in choosing the favourable pollinators and in synchronizing the flowering of parental pairs in hybrid seed production.

Introduction

Economic production of hybrid wheat seed largely depends upon intensity of cross pollination. Seed set percentage of maternal plants with sterile pollen is influenced by environmental conditions during flowering period, as well as by a number of characteristics of hybrid components. Accordingly, great differences in seed setting in plants with sterile pollen have not surprised research workers in their studies effected so far. Thus, WILSON—ROSS (1962) obtained 72.6 per cent seed set on male sterile plants with *Ae. ovata* type of sterility. PORTER *et al.* (1965) attained 1.8 to 14.1 per cent seed set on male sterile plants with *Ae. ovata* and *Ae. caudata* cytoplasm, KHERDE *et al.* (1967) obtained seed setting from 2 to 61 per cent in 1964, and 2—28 per cent seed setting in the year 1965, studying 45 pollinators with three types of sterility. BITZER—PATTERSON (1967) have found that seed setting on hand-emasculated plants depends directly on pollen load in the air during flowering, and the seed setting ranged from 39—66 per cent for the poorest pollinator to 58—91 per cent for the best pollinator. RAJKI (1962) obtained the highest seed setting percentages with three anthers, when pollinating emasculated wheat spikes with 1—2 and 3 anthers.

In general we can draw the conclusion that apart from other factors, the pollen load in the air during flowering of maternal plants has large influence on the cross pollination intensity. The pollen load in the air depends on the quantity of pollen produced per anther and on the number of anthers per unit area. Therefore, good pollinator in hybrid production, besides favourably combining ability and fertility restoration property, should possess high pollen productivity and ability to extrude anthers. CAHN (1925) was the first research worker who established significant differences in the anther length and the pollen grain number in varieties Kota and Marquis. KHERDE *et al.* (1967) found reasonable difference in the length and width of anthers among 45 pollinators. Soft red winter wheats had anthers longer and wider than that of other classes. JOPPA *et al.* (1968) found differences among 11 varieties of hard red spring and 3 durum wheats with respect to the number of pollen grains per anther, percentage of anther extrusion and some other characters. Pollen grain number per anther ranged from 2.687 to 3.867; and anther extrusion from 22 to 72 per cent. Amount of pollen extruded can be predicted for a variety based on percentage of anther extrusion, pollen grain number per anther and number of fertile florets per unit area.

In our studies we tried to find efficiency of production, speed and intensity of pollen extrusion for some varieties, which could be used as pollinators in hybrid seed production.

Materials and Methods

26 varieties were used in experiments conducted in 1969, whilst the speed of anther extrusion was determined only in 4 varieties in 1968 and 1969. All the varieties investigated are winter types; however, they differ very much in many characters, particularly in view of the length of vegetation. Plants for these studies were grown on small plots consisting of five 2-m rows, with row distance of 20 cms. The following methods were applied in our studies:

Anther extrusion. During heading of each variety 20 spikes were marked at the stage when the spike base was approximately 1 cm out of the top leaf sleeve. Nine days afterwards, the marked spikes were cut down and the number of anthers was counted in the primary, secondary and tertiary florets of each spikelet. Per cent anthers extruded was calculated as follows:

$$\text{per cent extrusion} = 1 - \frac{(\Sigma \text{ unextruded anthers/20 heads}}{3 \times (\Sigma \text{ fertile florets/20 heads})} \times 100$$

In varieties San Pastore, Etoile de Choisy, Abbondanza and Bánkuti 1201, 80 spikes were marked in 1968, and 60 spikes in 1969; and the number of anthers extruded was counted 3, 6, 9 and 12 days after heading.

Size of anthers. From each variety we have randomly taken 10 spikes. From one floret, and this refers to the primary, secondary and tertiary florets, near the centre of each spike 2 anthers were excised at the stage just prior to dehiscence and their length and width were measured. The measurements were done under a binocular microscope using a micrometer eye piece. If anthers had already dehisced, new samples from the same spike but from the next lower spikelet were taken.

Pollen grains/anther. We used the method of PEDERSON—JOHANSEN—JORGENSEN (1961) modified by JOPPA—MCNEAL—BERG (1968). 16 anthers were excised from two spikes

just prior to flowering and placed in a 4-ml vial, containing 2 ml of 1 per cent aceto carmine and five small glass beads. The vials were stoppered and shaken vigorously until all pollen grains had been dislodged from the anthers. From each variety we made 5 samples of this kind. From each specimen 8 small samples were placed beneath the cover slip of a standard hemocymeter. The pollen grains were counted in each of eight 1.0-mm^2 cells, and then converted to total pollen grains/anther.

Results and Discussion

Conditions were favourable for the growth of the material studied in both the years. The climatic conditions during the flowering period in 1968 were unfavourable for cross pollination due to high temperatures. In the year 1969 the weather conditions were by far more satisfactory than in 1968. However, early, medium early and late varieties differed evidently. In general, heading in 1969 for all varieties was approximately 10 days later in comparison to 1968.

Anther extrusion. Varieties differed considerably in the per cent of anthers extruded. Variety Francest had the lowest per cent of anthers extruded (32.2 per cent); Bánkuti 1201 — the highest (86.3 per cent). For the majority of varieties studied in 1969 the percentage of anther extrusion ranges between 60—70 (Table 1). Varieties with higher per cent of anthers extrusion are likely to be better pollinators, as well. This would be examined in our further researches. Almost for all the varieties investigated, the amount of anthers extruded from the primary and secondary florets is approximately the same, although considerably higher in comparison to other florets in spikelet.

For efficient production of hybrid wheat seed, both the percentage and speed of anther extrusion after heading are of great importance. Results of the studies performed in the course of the two years on 4 varieties are presented in Table 2 and Fig. 1. The varieties differed very much in the speed of anther extrusion, too. The highest speed of anther extrusion was found in the variety Bánkuti 1201, which, 3 days after heading, had 4.8 per cent anther extrusion in 1968, and 48.8. per cent in the year 1969. The remaining three varieties are much slower with regard to anther extrusion, and 3 days after heading, Abbondanza extruded no anther, in both 1968 and 1969. Varieties Abbondanza and San Pastore have approximately the same speed of anther extrusion, and the highest anther extrusion percentage is attained between 6 and 9 days after heading. Variety Etoile de Choisy is between San Pastore and Bánkuti 1201, so far as speed of anther extrusion is concerned. For all the varieties studied, the percentage of anther extrusion 9 days after heading remains the same or increases slightly. In 1969, therefore, anther extrusion 12 days after heading was not measured. When selecting the parental pairs, the varietal differences are to be considered in order to synchronize the flowering time with pollination and seed setting.

Table 1

Size of anthers, number of pollen grains/anther; per cent of extruded anthers and date of heading in 1969

Variety	Length of anthers mm	Width of anthers mm	Number of pollen grains/ anther	Anthers extruded, per cent	Date of heading
San Pastore	3.67	0.79	2031	58.3	16.5
A—3—M	3.81	0.91	2031	63.8	17.5
K—70—M	4.03	0.85	2562	69.7	18.5
Bánkúti 1201	4.03	0.90	2469	86.3	22.5
Chris	4.05	0.86	2531	71.1	16.5
H—303	4.07	0.94	2687	62.7	17.5
Abbondanza	4.10	0.89	2250	75.0	18.5
Libellula	4.18	0.87	2656	—	17.5
Castor	4.18	0.87	2781	61.2	26.5
307—A—I	4.20	0.87	3312	60.3	16.5
Etoile de Choisy	4.21	0.90	2406	67.8	19.5
Martin	4.28	0.88	2593	46.4	28.5
Prof. Marchal	4.36	0.93	2781	42.8	29.5
Ranka	4.38	0.98	2406	42.3	17.5
S—60—11—R	4.40	0.98	3187	75.1	21.5
Gudin	4.53	0.91	3937	65.9	28.5
Cleo	4.54	0.91	3031	37.1	25.5
Francest	4.63	0.88	3312	32.2	30.5
Abel	4.63	0.90	2781	50.7	27.5
Dranhofer Kolben	4.68	0.90	3187	67.2	28.5
Zg—3805/65	4.71	0.92	3812	70.8	17.5
K—111—M	4.73	0.94	3969	71.1	17.5
Mironovskaya 808	4.76	0.93	3625	65.1	26.5
Busard	4.80	0.93	3250	48.0	30.5
Weigue	5.05	0.90	3750	62.3	4.6
Primepi	5.25	1.01	5094	59.6	25.5
LSD — 5%	0.14	0.05	562	11.9	
1%	0.18	0.07	750	15.6	

Size of anthers. Significant differences in anther length and width were recorded for the varieties studied (Table 1). The smallest anthers are of San Pastore, and the biggest of Primepi. Correlation coefficient between anther length and width amounts to 0.59; this indicated that the longest anthers are also the widest. KHERDE *et al.* (1967) found for these characters the correlation coefficient of 0.48. The mean size of anthers for all the varieties examined

Table 2

Per cent anthers extruded at 3, 6, 9, and 12 days after heading, in 1968—1969

Variety	Days after heading							
	3 days		6 days		9 days		12 days	
	1968	1969	1968	1969	1969	1968	1968	1969
San Pastore	0.00	9.17	15.26	19.02	62.59	58.33	62.46	—
Etoile de Choisy	3.88	0.00	69.41	30.24	74.89	67.77	75.78	—
Abbondanza	0.00	0.00	13.31	9.39	74.49	75.00	80.43	—
Bánkuti 1201	4.85	48.83	66.80	76.03	78.43	86.27	81.49	—

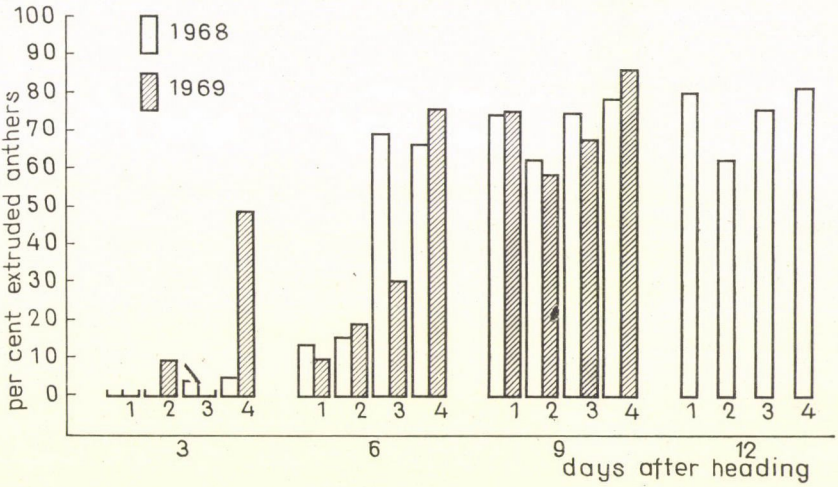

Fig. 1. Per cent of extruded anthers at 3, 6, 9 and 12 days after heading, in 1968—1969. (1 = Abbondanza, 2 = San Pastore, 3 = Etoile de Choisy, 4 = Bánkuti 1201)

by KHERDE and collaborators was smaller than the one shown by our results. They determined the mean length as 3.87 mm, the width 0.80 for 45 varieties measured. According to our results the mean anther length for 26 varieties examined was 4.39 mm, the width 0.90 mm. We suppose the main reason for the differences lies in the fact that KHERDE and collaborators determined size of anthers which were previously fixed in the FAA solution, while in our studies fresh anthers were measured.

Anthers from the primary and secondary florets do not vary in size. Accordingly, the mean anther length from the primary floret was 4.41, and from the secondary floret 4.37 mm. The anther width of the primary floret was 0.91; of the secondary floret 0.89 mm. However, anthers of the tertiary floret were significantly smaller in relation to anthers of the primary and

secondary florets. The mean anther length of the tertiary floret (for all varieties) amounted to 4.02; the width 0.78 mm.

Number of pollen grains/anthers. Varieties significantly varied in number of pollen grains/anthers. The lowest number of pollen grains/anthers was in the varieties San Pastore and A-3-N (2.031), and the highest in Primepi (5.094). The latter variety markedly exceeds all the varieties examined in size of anthers and number of pollen grains/anthers. All the varieties measured had pollen grains number/anthers below 4.000, except Primepi with 5.094.

Varieties with larger anthers have also more pollen grains/anthers. Correlation coefficient between anther length and number of pollen grains/anthers amounts to 0.87; between anther width and number of pollen grains/anthers 0.54 (Table 3). On selecting genotypes with larger anthers, production of pollen per anther increases.

Table 3

Simple correlation coefficients (r) for five characteristics observed in 1969

Character correlated	Width of anther	Pollen grains/ anther	Vegetation period	Anthers extruded
Length of anthers	0.59++	0.87++	0.57++	0.02
Width of anthers	—	0.54++	0.13	0.01
Pollen grains/anther	—	—	0.36	0.00
Vegetation period	—	—	—	0.18

There is positive correlation between length of vegetation and anther length (r = 0.57). Later varieties have larger (longer) anthers, and more pollen grains/anthers (r = 0.36). These results are to be verified through several years or at more locations in order to determine the effect of weather conditions upon the correlation ratio obtained. In this year, might be, climatic conditions were more satisfactory for development of anthers in late varieties, that is to say, unfavourable for early varieties.

We could not determine correlation between percentage of anther extrusion and other characters studied, i.e. length and width of anthers, number of pollen grains per anthers and length of vegetation (Table 3).

Although results of one year studies are presented, and these should be checked in the next years, nevertheless, they might be useful in choosing the favourable pollinators and in synchronizing the flowering of parental pairs for hybrid seed production.

REFERENCES

BITZER, M. J.—PATTERSON, F. L. (1967): Pollen dispersal and cross pollination of soft red winter wheats. Crop Science, **7**, 482—484.

CAHN, E. (1925): A study of fertility in certain varieties of common wheat with respect to anther length and amount of pollen in parents and offspring. J. Amer. Soc. Agron., **17**, 591—595.

JOPPA, L. R.—MCNEAL, F. H.—BERG, M. A. (1968): Pollen production and pollen shedding of hard red spring (*Triticum aestivum* L. em Thell.) and durum (*T. durum* Desf.) wheats. Crop Science, **8**, 487—490.

KHERDE, M. K.—ATKINS, I. M.—MERKLE, O. G.—PORTER, K. B. (1967): Cross pollination studies with male sterile wheats of three cytoplasms, seed size on F_1 plants and seed and anther size of 45 pollinators. Crop Science, **7**, 389—394.

PEDERSON, P. N.—JOHANSEN, H. B.—JORGENSEN, J. (1961): Pollen spreading in diploid and tetraploid rye. Importance of pollen quantity and pollen distribution for the percentage of seed setting in the ears. Den Kogelige Vetainaer-Og Landbohojskole Year book 1961. 54—86.

PORTER, K. B.—KEITH, A. LAHR—ATKINS, I. M. (1965): Cross-pollination of male-sterile winter wheat (*Triticum aestivum* L.) having *Aegilops caudata* L. and *Aegilops ovata* L. cytoplasm. Crop Science, **5**, 161—163.

RAJKI, E. (1962): A bibére jutó pollen mennyiségének hatása a megtermékenyülésre (Effect on pollination of the amount of pollen on the surface of stigma). Növénytermelés, **11**, 35—44.

WILSON, J. A.—ROSS, W. M. (1962): Cross breeding in wheat *T. aestivum* L. II Hybrid seed set on a cytoplasmic male-sterile winter wheat composite subjected to cross pollination. Crop Science, **2**, 415—417.

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TEST ON TERPENOIDS PRESENT IN PARTS OF CORIANDRUM SATIVUM L.

III. HISTOLOGY OF THE DEVELOPING STRUCTURES OF CORIANDRUM SATIVUM L. VAR. "LUČ" AND PROPERTIES OF VOLATILE OIL CANALS

By

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Histological investigations were carried out on *Coriandrum sativum* L. var. "Luč" in the course of ontogenesis. It was established that the volatile oil canals of vegetative organs and the epithelial cells of the peripheral canals of the fruit are not suberized. Moreover deviation can be found only as regards their topography and size. In contrast with this, the epithelial cells of the inner canals of the fruit are suberized.

Introduction

The composition of volatile oil in the coriander changes during ontogenesis. In the course of our investigations the volatile oil of pericarp and seedling of *Coriandrum sativum* var. "Luč" was first studied (Lassányi—Lőrincz 1967) followed by studies on the changes of linalool and aldehydes with thin-layer chromatographic and histochemical methods (Lassányi—Lőrincz 1968).

This paper deals with the development of volatile oil canals in connection with histology.

The *Umbelliferae* family is relatively uniform therefore many similarities are to be found in the developed structures of coriander for example in *Aegopodium podagraria* L. (Korta 1962), as regards root structure formation to fennel (Bruch 1956, Rørdam 1966), in the organization of the flower, or the fruit to *Heracleum mantegazzianum* (Kovács 1966) or to *Foeniculum vulgare* (Sárkány 1964). Haccius—Retz (1955—56) studied the seedlings — among them also coriander — belonging to the *Umbelliferae* family, from a morphological and anatomical point of view. As regards the structure of the developed plant tissues more information can be found in Metcalf—Chalk's book (1950). A microscopical description of the ripe fruit can be found in Pharmacopoeias (e.g. Pharmacopoeia Hung. Ed. V. 1954, *Gosudarstvennaya Farmacopeya* S.S.S.R. Ed. IX. 1961). Valuable data on volatile oil canals are given in Borotynska's (1956) work.

Materials and Methods

Our test material was the high volatile oil containing coriander variety "Luč" cultivated at the Budakalász Experimental Station of the Scientific Research Institute for Medicinal Plants in 1965 and 1966.

In 1965 the plants were flooded by the Danube in the flowering period. In 1966, neither the Danube nor significant insect damage, or disease affected the experiment.

Sowing was done in both years in the optimum time. The distance between the rows was 40 cm.

The time and marking of the 1966 investigation material are indicated in Table 1. It should be mentioned, that the plants were collected at equally developed stages in 1965. The plants were used for destillation of volatile oil and histochemical and histological examinations. For the histological test, the material was fixed in Navashin fluid (SÁRKÁNY—SZALAI 1964). One part of the fixed material was embedded in paraffin in the usual way. The thickness of the sections was 13—15 μ. The sections were stained with Ehrlich's hematoxylin and mounted in Canada balsam. The other part was embedded in polyoxatene stearate (LASSÁNYI 1967). The material rinsed from the fixative was placed in a watery solution of polyoxatene 1500 and changed daily. The quantity of polyoxatene 1500 in the solution was raised daily (5, 10, 15, 20, 50, 70 per cent) and at 70 per cent the material under test was placed in the previously melted mixture of 2/3 polyoxatene 1500 and 1/3 polyoxatene stearate and finally in the mixture of the two substances in the same proportion. The embedding was performed in a thermostat kept at 37—40°C till addition of the polyoxatene stearate and then at 50—55°C.

To affixing the sections (RIOPEL—SPURR 1962) a mixture of gelatin, water, glycerin and phenol (5 : 120 : 40 : 2) was used. According to REID—SARANTAKOS (1966) the slides with the sections were held over boiling waterbath. The adhesion of the sections can be helped by placing formalin in open vessels in a thermostat of 37—40°C and keeping the preparations there over night. After rinsing the sections are stained with 1 per cent toluidine blue solution and mounted with polyvinyl alcoholic mixture according to SPURR (1954) (composition: 40 g distilled water, 34 g cadmium iodide, 18 g polyvinyl alcohol and 8 g fructose). Thicker sections were prepared with this method 18 μ.

The suberization could be demonstrated by staining with alcoholic Sudan IV. Freehand sections were also prepared in order to get more information in this way than by serial section.

Results and Discussion

The root of coriander has a diarch structure. Primary volatile oil canals can be found even at the lignification of the protoxylem. These (in cross-section appear in a semi circle) are lined by 3 or 4 epithelial cells and are arranged in the pericambium. At the beginning the endodermis has casparian-strip and a few rows of parenchyma are found the external part of which is covered by a rhizoderm. With the thickening of the root the primary endoderm is transformed into secondary endoderm, i.e. the endoderm cells suberize circularly and turn a Sudan IV red colour (stage 3) in addition, the volatile oil canals begin to flatten, the primary cortex comes off. The paracambium forms in the pericambium similarly to most dicotyledons (ESAU 1960, KAUSSMANN 1963).

In the course of cambial activity new volatile oil canals develop in groups and are arranged incircles. In older roots similarly to the *Aegopodium podagraria* root (KORTA 1962) rexigenous intercellular spaces are found in the secondary cortex (Fig. 1). The tissue arrangement is similar in a large part of the hypocotyl, showing a root structure except that it is covered with rhizoderms instead

Table 1

Dates and serial numbers of the material

No.	Date of sampling	Developmental stage of the plant
1	IV. 8	With two cotyledons
2	IV. 15	With one foliage leaf
3	IV. 22	With two foliage leaves
4	IV. 29	With three foliage leaves
5	V. 6	With four foliage leaves and one leaflet
6	V. 11	With five foliage leaves and one leaflet
7	V. 20	Shooting up, the cotyledons begin to wilt
8	V. 24	Budding, the cotyledons are dried
9	V. 27	Flowering begins
10	VI. 3	
11	VI. 7	The main umbel is in full bloom
12	VI. 10	The plant is in full bloom
13	VI. 14	The formation of the green fruit in the main umbel
14	VI. 20	The formation of the green fruit in the 1, 2, 3 branchings
15	VI. 23	The main umbel is yellowish-green
16	VI. 28	The lateral umbels begin to get yellow
17	VII. 1	
18	VII. 5	
19	VII. 8	
20	VII. 12	
21	VII. 15	The lower leaves begin to get yellow, the fruit of the main umbel begins to ripen
22	VII. 19	Half of the plant is partly dried, 20% ripe fruit
23	VII. 22	The plant is dried in 90%, the ripe fruit is 70 per cent
24	VII. 28	The plant is dried, the fruit is ripe

of epidermis. The diarch structure turns into the collateral bundles only in the topper part as described by HACCIUS—RETZ (1955—56) (Fig. 2). The rapid formation of the secondary volatile oil canals is connected with the speedy development of the overground parts.

In the lower part of the stem, the foliage is rather close to each other (short internode), later the plant shoots up (stage 7). This is also reflected by the appearance of the tissue. The exterior of the short internode is covered with epidernis, below in cross-section a few rows of chlorechyma and volatile oil canals can be found, however their course is not so regular as that in the long internodes. The vascular system is in bundles but as bundles, decurrent from the leaves join the vascular system of the stem bigger and smaller bundles

can be seen. It is interesting that in the transition from hypocotyl to the stem, volatile oil canals cannot be found in the parenychmatous pith, these only appear in the higher levels and branch, ending in blind alleys. Further up still they run horizontally and do not anastomize each other.

In the long internodes under the epidermis, the collenchyma and chlorenchyma alternate in bundles. The collenchyma is found near the big bundles followed by a circle of the vascular bundles, bigger primary bundles alternate

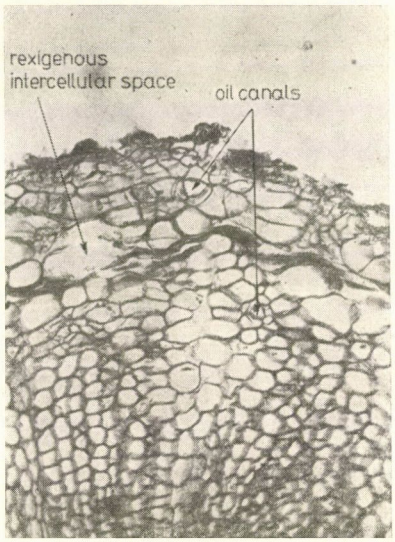

Fig. 1. The cross-section of the root (280×)

Fig. 2. The cross-section of the hypocotyl (100×)

with smaller secondary ones and between them an interfascicular cambium is found. When the fascicular cambium and the interfascicular cambium have finished their activity they turn into sclerenchyma and a lignified fixing ring develops in their place (Fig. 3). The volatile oil canals are arranged between the phloem of the big bundles and the collenchyma. They grow acropetally and the number of the epithelial cells is 13—18. The pith is parenchymatous with cells which round off later and schizogenous intercellular spaces form in the corners. The pith later breaks in the lower internodes and at this time many of the volatile oil canals inside are destroyed.

Altough there is heterophylly in the coriander, the internal structure of variously shaped leaves is very similar.

The bifacial structure of the cotyledons consists of two rows of palisade parenchyma and a few layers of spongy parenchyma under the epidermis. The volatile oil canals occur under the midrib and the two small lateral veins. These canals are bigger with 5—6 epithelial cells in cross-section. Besides this

above the veins volatile oil canals are found but they are smaller. Here the palisade parenchyma stops.

The tissue arrangement is the same in the lamina. The stalk is triangular in cross-section and collenchyma is found in the triangles under the epidermis, while below this three big bundles are situated. The rest is built up of parenchyma. The volatile oil canals partly accompany the phloem of the vascular bundles (these are the bigger ones) but smaller ones may be found besides these. Their

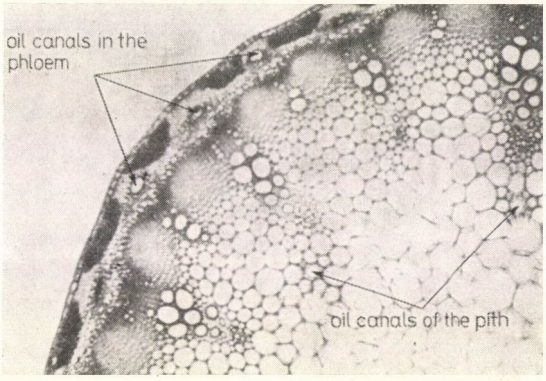

Fig. 3. The cross-section of long internode (100×)

development can be seen in Fig. 4. The fruit is a diachaenium which when ripe splits under pressure into two pericarps. Detailed description of this will not be given here since it can be found in every Pharmacopoeia in which the coriander is official (e.g. Pharmacopoeia Hung. Ed. V. 1954) or pharmacognosy book (e.g. HALMAI—NOVÁK 1963). Already in the pistil as well as in the green fruit peripheral and internal volatile oil canals can be observed in the mesocarpium. The peripheral canals are arranged between the epidermis and the sclereidal ring, in the course of ripening they become completely flat and lose their contents, the internal ones — two of them in both mericarpium — are near the carpophore in each mericarpium, these do not flatten in the course of ripening, in fact they retain their contents even after germination (LASSÁNYI—LŐRINCZ 1967).

Our observations agree with those in the literature. The volatile oil canals arise in a schizogenous way and the space among the epithelial cells increases further (KAUSSMANN 1963, KOVÁCS 1966). It is characteristic of the epithelial cells that their shape is roughly izodiametric, their plasma stains well, and they contain big nuclei. According to BOROTYNSKA (1956), the oil drops quite often settle around the wall near the space of the epithelial cells. MOENIKES (1924) gives a similar account of investigations carried out on *Pimpinella saxifraga*, *Angelica officinalis* and *Levisticum officinalis*. "Diese

Tröpfchen waren zum Teil regellos im Protoplasten zerstreut, doch fanden sich häufig Zellen, in denen einige wenige Tröpfchen mitten im Plasma zu sehen waren, die meisten jedoch an der Seite des Protoplasten angehäuft hatten, die der Membran zum Harzkanal hin angelagert war." Similar granulation was found by us, but only in sections embedded in paraffin.

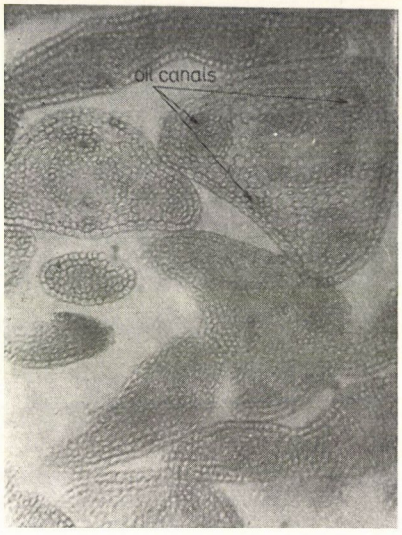

Fig. 4. The cross-section of vegetative point (280×)

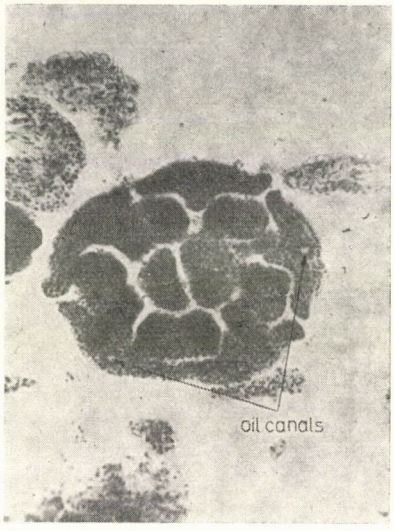

Fig. 5. The cross-section of the developing flower (280×)

BOROTYNSKA (1956) examined the process of suberization at the epithelial cells. She found that the epithelial cells of the primary canals of the root, as well as of the fruit are suberous. According to our results, only the epithelial cells of the inner canals of the fruit are suberous, the others are not. However the walls of the epithelial cells in the pith and connected with the lignified parenchymatous cells of the same, give the lignin reaction.

Similarly to Borotynska the authors also found different oil canals in the "Luč" variety. The so-called "canals of the phloem" pass through the whole plant (in the root, in the primary cortex of the stem, in the leaf, in the petals, and on the outside of the pistil) (Fig. 6). Their formation in the leaf according to our observations precedes the lignification of the protoxylem. The other type, which is in the pith ends blindly. The internal canals of the pistil and the fruit, respectively, belong to separate types. Those belonging to the fruit end blindly (Fig. 6) with suberous epithelial cells and after suitable treatment they can be prepared from the pericarp after germination. As our earlier histochemical investigations proved (LASSÁNYI—LŐRINCZ 1968) the epithelial cells of the volatile oil canals belonging to the first two types are

not suberous and they differ from each other only as regards topography and size. Volatile oil forming in them contains aldehydes. But the inner volatile oil canals, which contain linalool (LASSÁNYI—LŐRINCZ 1968) as result of the present histochemical investigations deviate from the above mentioned ones in the definite formation of their epithelial cells, that is, their cell walls are

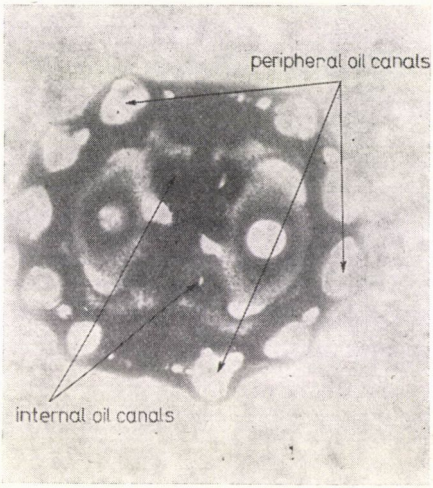

Fig. 6. The cross-section of the pistil (100×)

suberized. According to us, the cell wall of the mentioned volatile oil canals may be connected with the difference of the volatile oil composition. Since the characteristic of the cork is its impermeability, it seems reasonable that the linalool remains after germination too (LASSÁNYI—LŐRINCZ 1967).

Conclusion

It was established that the tissue composition of the coriander was very similar to the other plants belonging to the Umbelliferae family. The primary volatile oil canals are situated in that part of the root and hypocotyl, which has a root-structure arranged in a pericycle. The secondary ones are formed in concentric groups. One can differentiate canals, which are in the phloem of the bundles, these can pass through into the leaves, flowers, and such which are found in the pith. The latter end blindly. There are two kinds of volatile oil canals in the fruit. Canals situated on the periphery are connected with the ones in the stem. Both inner canals end blindly in the fruit. In the latter the wall of the epithelial cells is suberous while in others, the suberization cannot be demonstrated.

REFERENCES

BOROTYNSKA, W. (1956): Rozwój przewodów wydzielniczch w kolendrze siewnej (*Coriandrum sativum* L.). Biuletyn Panstwowego Instytutu Naukowego Leczniczych Surowców Roslinnych w Poznaniu, **2,** 13—23.

BRUCH, H. (1956): Beiträge zur Morphologie und Entwicklungsgeschichte der Fenchenwurzel (*Foeniculum vulgare* Mill.). Beiträge zur Biologie der Pflanzen, **32,** 1—26.

ESAU, K. (1960): Anatomy of seed plants. John Wiley & Sons, Inc., New York, London.

Государственная Фармакопея СССР (1961): Девятое издание, Медгиз. Москва.

HACCIUS, B.—RETZ, K. (1955—56): Morphologische und anatomische Untersuchungen an Umbelliferen, Keimpflanzen. Beitr. Biol. Pfl., **32,** 186—216.

HALMAI, J.—NOVÁK, I. (1963): Parmakognozia (Parmacognosy). Medicina, Budapest.

KAUSSMANN, B. (1963): Pflanzenanatomie. Gustav Fischer Verlag, Jena.

KORTA, J. (1962): *Aegopodium podagraria* L. Podagrycznik pospolity L'Egopode podagraria. I. Analise anatomique. Acta Biologica Cracoviensia Sr. Bot., **5,** 63—76.

KOVÁCS, A. (1966): Szövetfejlődéstani tanulmányok a *Heracleum mantegazzianum* (Somm. et Lev.) termőjén (Histogenic studies on the pistil of the *Heracleum mantegazzianum* Somm. et Lev.). Egyetemi doktori értekezés (University Doctor's Thesis), Budapest.

LASSÁNYI, ZS.—LŐRINCZ, C. (1967): Test on terpenoids present in parts of *Coriandrum sativum* L. I. Thin-layer chromatographic examination of the volatile oil of the pericarpium and seedling of the "Luč" variety. Acta Agronomica Acad. Sci. Hung., **16,** 95—100.

LASSÁNYI, ZS.—LŐRINCZ, C. (1968): Test on terpenoids present in parts of *Coriandrum sativum* L. II. Thin-layer chromatographical examination of linalool and aldehydes. Acta Agronomica Acad. Sci. Hung., **17,** 215—222.

LASSÁNYI, ZS. (1967): Vízoldékony kenőcsalapanyagok használata illóolajtartalmú növények beágyázásához (The use of water soluble ointments basic material for embedding of the plants containing volatile oil). A Magyar Biológiai Társaság Botanikai Szakosztályának ülésén elhangzott előadás (Lecture at a Session of the Botanical Department of the Hungarian Biological Society).

METCALFE, C. R.—CHALK, L. (1950): Anatomy of the Dicotyledons. Calderon Press, Oxford.

MOENIKES, A. (1924): Zur Frage der Harzbildung bei Umbelliferen, Compositien und Araliazeenwurzeln. Bot. Archiv., **5,** 91—109.

V. Pharmacopoeia Hungarica (1954): III. 53. Egészségügyi Kiadó, Budapest.

REID, J. D.—SARANTAKOS, G. (1966): Infiltrating and embedding tissues with mixtures of polyethylene glycols and polyvinyl acetate resins. Stain Technol., **41,** 207—210.

RIOPEL, J. L.—SPURR, A. R. (1962): Carbowax for embedding and serial sectioning of botanical material. Stain Technol., **37,** 357—362.

RØRDAM, A. M. (1966): Oliekanalen i skaermptanterdødder den primaere dannaelse. Dans Tidsskr. Farm., **40,** 131—139.

SÁRKÁNY, S.—SZALAI, I. (1964): Növénytani praktikum. I. Növényszervezettani Gyakorlatok (Practical Botany. Botanical Structure Exercises). Tankönyvkiadó, Budapest.

SÁRKÁNY, S. (1962): Organisation des Stempels und der Spaltfrucht von *Foeniculum vulgare* Mill. und die Frage des sogenannten unterständigen Fruchtknotens. An. Univ. Sci. Budapestiensis de Rolando Eötvös nominate. Sect. Biol., **5,** 193—224.

SPURR, A. E. (1954): Polyvinyl alcohol with cadmium iodide and fructose as an aqueous mounting medium. Stain Technol., **29,** 301—313.

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EFFECT OF MALEIC HYDRAZIDE ON FLOWER FORMATION IN EGG-PLANTS (SOLANUM MELONGENA L.)

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By injecting 1 cm^3 of 0.01 per cent maleic hydrazide solution into the main axis of inflorescence of the egg-plant with a single treatment, the effect of the maleic hydrazide solution can be studied in almost every phase of sporogenesis within the same bostryx. As a result of the injection in the individual flowers of the inflorescence various changes occur. These changes (absence of filament, absence of anther, absence of pollen, sterile pollen, sterile and fertile pollen produced simultaneously, non-dehiscent anthers with fertile pollen, dehiscent anthers with fertile pollen) show relationships among flower formation, micro-sporogenesis, apertures of anthers and the effect of the maleic hydrazide solution.

Introduction

Maleic hydrazide has often been applied as a growth inhibitor and used to induce pollen sterility in various plants. Maleic hydrazide was used as a compound inducing pollen sterility in maize (MOORE 1950, DENISEN—HAKER 1950, ZDRILKO 1962), tomato (REHM 1952), cucurbits (WITTWER—HILLYER 1954), sunflower (JAIN 1959, SCHUSTER 1961), wheat (SIKKA—JHA—SWAMINATHAN 1959, CHOPRA—JAIN—SWAMINATHAN 1960), potato (CHOPRA—JAIN—SWAMINATHAN 1960), onion (CHOPRA—JAIN—SWAMINATHAN 1960, KAUL—SINGH 1968), vine (IYER—RANDHAWA 1965), beans (KAUL—SINGH 1967), broad-bean (SCOTT 1968).

The effect of maleic hydrazide depends on the concentration of the applied solution, the quantity of solution per plant, as well as on the stage of micro-sporogenesis at the time of application.

In the course of micro-sporogenesis, treatments applied before the development of archesporium cells or after the appearance of microspores do not cause any change. Maleic hydrazide applied at the time of commencement of reduction divisions by the archesporial cells disturbs the reduction division and further growth of anthers stops. With an application during microspore formation, development of anthers and pollen is normal.

As a reaction to maleic hydrazide treatment partial or total pollen sterility, complete destruction of flowers (ZDRILKO 1962), functional or staminal pollen sterility (KAUL—SINGH 1967), underdeveloped female sexual organs in bisexual plants (ZDRILKO 1962), regression of anthers and protogyny instead

of protandry (ZDRILKO 1962) in eared and lingulate plants, cells with unbalanced chromosome numbers appearing in the course of microsporogenesis (CHOPRA 1960), coagulation of chromosomes into undifferentiated chromatin at metaphasis (CHOPRA 1960) and development of double embryos can be observed.

Materials and Methods

The plant used in our experiments was egg-plant *Solanum melongena* L. Within the species *Solanum melongena* L. we examined *Solanum melongena* L. ssp. *occidentale* Haz. var. *bulgaricum* Fil. — according to FILOV's system (1958).

Egg-plant has a complex inflorescence, namely: bostryx. In a bostryx the number of flowers is 1—5.

On the basis of external morphological characters the different stages of microsporogenesis can hardly — if at all — be determined without destroying the flowers. Namely, the different stages of the process of microsporogenesis do not cause obvious morphological changes in the course of budding, that is, positive correlation — if it exists at all — cannot be shown between the apparent morphological changes and the stages of microsporogenesis.

In the pollen sac *(loculamentum)* when the sporogenous tissue develops, the archesporial cells transform into pollen mother cells after a few divisions. From the pollen mother cells the pollentetrads develop through reduction. The cell walls of the tapetum layer dissolve, the periplasm developed from the protoplasm of the tapetum cells surrounds the pollens. Between the stages of pollen development precisely determinable change in budding cannot be observed. However, the existence of developed pollen can be established by the mechanism of flower opening, that is, on the basis of morphological characters.

In the bostryx of the egg-plant time-lag can be observed between the development of the individual flowers. In other words, in bostryxes, flowers are in different stages of development in an acropetal order of succession. Consequently, the process of microsporogenesis is also in different stages in them.

Thus, microsporogenesis being in different stages in the individual flowers of the bostryx, flowers receive maleic hydrazide injected into the main axis of the bostryx at different phases of development, — even if it cannot be concretely determined. Consequently, maleic hydrazide solution injected into the main axis of inflorescence must have different effects — in an acropetal order of succession — on the individual flowers.

Taking into consideration that maleic hydrazide was applied either as drops to plants yet to start flowering (SCHUSTER 1961), or was injected into the flower (KAUL—SINGH 1968), we injected 1 cm^3 of 0.01 per cent maleic hydrazide solution into the main axis of each of 100 bostryxes of the egg-plant. The solution was applied at a time when pollen grains had already developed in the flowers at the bases of bostryxes (the corolla assumed colour), while other flowers were in successively earlier stages of flower formation and microsporogenesis. After the injection the bostryxes continued to develop and the individual flowers blossomed. After all flowers had opened (15—20 days) we picked the bostryxes and determined the changes occurred in the individual flowers. Preparation was observed under a Zeiss Cytoplast stereobinocular microscope, the pollen grains were stained — in order to determine sterility and fertility — with Geitler's carmineacetic acid. Bostryxes left on the plants as controls withered and then fell off without forming a separation zone.

Results

Flowers reacted with various changes to maleic hydrazide solution injected into the main inflorescence axis of egg-plant. These changes depended on the stage of development of individual flowers at the time of application. The effect of the 0.01 per cent maleic hydrazide solution is shown in Table 1. Data in Table 1 show that the effect of the maleic hydrazide solution depends

Table 1

Distribution of changes observed in flowers

Mode of change	Percentage of changes observed in the			
	first	second	third	fourth
	flower of the bostryx			
Even the filament does not develop	—	—	2.5	52.3
Filament develops but anther does not	—	—	7.5	29.9
Anther develops but does not contain pollen	—	2.5	76.6	17.8
Anther contains sterile pollen and does not open	—	25.5	13.4	—
Anther contains both sterile and fertile pollen, and does not open	—	67.5	—	—
Anther contains fertile pollen but does not open	3.6	4.5	—	—
Anther opens and contains fertile pollen	96.4	—	—	—

on the stage of development, or microsporogenesis at the time of treatment. Namely, maleic hydrazide solution influences not only the flower formation and the course of microsporogenesis, but also that of macrosporogenesis (ZDRILKO 1962). If the flowers (the youngest one at the top of the branches of bostryxes) receive the effect at a time when the androceum is differentiating at the reproductive growing tip, highly different changes occur in the androceum. Filaments or anthers may be lacking, or anthers may not produce pollen — that is, the development of reproductive organs is not normal.

In flowers which are in a more advanced stage of development at the time of the treatment, filaments and anthers develop, but the anthers contain either only sterile, or sterile and fertile, or a low amount of fertile pollen, and do not open up. Thus, first pollen sterility, then functional male sterility can be observed. In flowers where at the time of the treatment the corolla had already assumed colour but had not yet opened, no change was observed. Anthers of such flowers opened and variable quantities of pollen — mostly fertile — were found in them. Of course, a low amount of sterile pollen could be found here too, but it is a feature characteristic of the species.

Changes were different even within the same flower. There were cases when one or two stamens developed, but without anthers; in the same flower anthers of certain stamens did not contain pollen while in others sterile pollen grains were found and the anther did not open. Similarly, within one flower there are stamens with anthers containing both sterile and fertile pollen, non-dehiscent anthers with fertile pollen, and dehiscent anthers with fertile pollen. Moreover, we can find — though not often — anthers where between the two halves essential quantitative difference can be observed with regard to sterility and fertility; besides — also rather infrequently — apart from the tetrads, development of diads, triads and pentads can also be observed.

Changes observed in flowers developing in an acropetal order of succession — absence of stamens, anthers, pollen, sterile pollen, sterile and fertile pollen together, non-dehiscent anthers with fertile pollen, dehiscent anthers with fertile pollen — show relations between flower formation, microsporogenesis, apertures of anthers and the effect of maleic hydrazide solution. Changes occurring as a reaction to 0.01 per cent solution of maleic hydrazide in flowers developing in an acropetal order depend on the stage of development of flowers and microsporogenesis, in other words, maleic hydrazide solution has different effects on flowers differing from one another in their stage of development.

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REFERENCES

CHOPRA, V. L.—JAIN, S. K.—SWAMINATHAN, M. S. (1960): Studies on the chemical induction of pollen sterility in some crop plants. Ind. J. Genet., **20,** 188—199.

DENISEN, E.—HAKER, E. (1950): Pouziti hydrazidu kyseliny maleinové pro sterilizaci kukorice. North Centr. Weed Contr. Conf. Res. Rep., **147.**

FILOV, A. I. — Филов, А. И. (1958): Баклажан — *Solanum melongena* L. Культурная Флора СССР **20,** Селхозгиз, 351.

HANSER, H. C. (1966): Zur Beeinflussung der Reproduktivität durch Alpha-Naphthylessigsäure und Maleinsäurehydrazid bei einigen Apfelsorten. Hohenheim, Landw. Hochschule, 118.

IYER, C. P. A.—RANDHAWA, G. S. (1965): Chemical induction of pollen sterility in grapes. Current Dci., **34,** 411—412.

JAIN, S. K. (1959): Male sterility in flowering plant. Bibliogr. Genet., Haag, **18,** 101—166.

KAUL, C. L.—SINGH, S. P. (1967): Staminal and functional male sterility induced by chemical treatment in papilionaceous plants. Indian J. Agric. Sci., **37,** 264—269.

KAUL, C. L.—SINGH, S. P. (1968): Induction of male sterility in *Allium cepa* L. Curr. Sci., **36,** 676—677.

MOORE, R. (1950): Pouziti hydrazidu kyseliny maleinové pro samci sterilizaci kukurice. Science, **112,** 52—53.

REHM, S. (1952): Male sterile plants by chemical treatments. Nature, **170,** 38—39.

SCHUSTER, V. (1961): Untersuchungen über künstlich induzierte Pollensterilität bei Sonnenblumen (*Helianthus annuus* L.). Z. Pflanzenz., **46,** 389—404.

SCOTT, D. (1968): The additive effect of X-rays and maleic hydrazide in inducing chromosomal aberrations at different stage of the mitotic cycle in *Vicia faba.* Mutation Research, **5,** 65—92.

SIKKA, S. M.—JHA, K. K.—SWAMINATHAN, M. S. (1969): Monosomic analysis in bread wheat II, Identification of chromosome carrying genes for awning and glume beak. Indian J. Genet., **19,** 56—63.

WITTWER, S.—HILLYER, I. (1954): Chemical induction of male sterility in cucurbits. Science, **120,** 893—894.

ZDRILKO, A. F.— Здрилко, А. Ф. (1962): Получение растений с мужской стерильностью путем химических воздействий. Тр. Укр. научно-иссл. инст. раст. генет., **7,** 135—153.

ZIMOVÁ, D. (1966): A hímsterilitás felhasználása a hibridvetőmag előállításánál (Utilization of male sterility in hybrid seed production). OMgK Budapest, 9—11.

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SOME BIOLOGICAL AND ECOLOGICAL INVESTIGATIONS ON ONION LEAF-MINER DIZYGOMYZA CEPAE HER.

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Experiments were carried out from 1965 to 1967 to determine the time of occurrence and abundance of *Dizygomyza cepae* Her., the evolution of its infection and the susceptibility of onion varieties to it. Moreover the larvae, the mines they form, and the pupation period were also under observation and the obtained results are reported.

Introduction

D. cepae is a small fly, first discovered in Germany by HERING (1927). The female lays her eggs in the epidermis of leaves of the onion plant. Each larva forms several tunnels (Fig. 1) and makes an exit hole in the epidermis.

Fig. 1. Each larva forms several tunnels

The feeding of females and sucking of larvae cause disturbance in the assimilation of plants. The moisture content of the attacked leaves is decreased by evaporation and the wilting of leaves starts very quickly from the top downwards.

STELLWAAG (1931), EICHLER (1950), NIETZKE (1953), HERING (1956), observed injury on onion plants in Germany. ISAJEV (cit.: NIETZKE 1953) found damage on plants between 1927—1930 in the Rostov region, and KALANDADZE—SHAVKATSISHVILI (1958) observed injury of the plants in the Republic of Georgia.

Materials and Methods

During field investigations the following were used:

1. Earth-traps

A) Tumblers: (200 ml) filled with salt-water to the half or two thirds and inserted in the soil so that their edges must be levelled with the surface.

B) Yellow-dishes: from plastic, 8 cm deep, 18×18 cm wide, filled with salt-water and inserted in the soil.

2. Onion varieties

The earth-traps were placed among onion plants grown for seeds at Makó (in southern Hungary) and at Soroksár (Experiment Station of the University of Horticulture) in different varieties grown from the seeds: "Makói", "Braunschweigi", "Fehér csemege", "Zittaui", "Vertus", "Téli sarjadék" and "Makói onion sets".

3. Keeping method

Transfer of the captured flies to small vials filled with 4/5 part of 70 per cent alcohol + 1/5 part glycerine took place every day during the vegetative period.

4. 100 plants method

100 plants had been tested from every plot gathered at random to determine the field infection.

5. Experimental plots

A) In 1965 both at Soroksár and Buda 1×1 m plots were used in a randomized block design with four replications.

These investigations were made to test the injury made (in 1966) by onion leaf-miner in the different onion varieties sown in autumn, 1965.

B) In 1966, at Soroksár, 5×5 m plots with four replications each were used to define the damage by *D. cepae* in different onion varieties from May to September.

Results

1. Population of Dizygomyza cepae (Her.), on the basis of data obtained by earth-traps

Investigations were carried out in Makó, 1966, in three onion fields (onion sets, onion for consumption, and onion grown for seeds). Five tumblers and two yellow-dishes were placed in every onion field from 18th May till 26th July. Experiment was also conducted at Makó, July 1967, on onion varieties grown from seeds, for consumption, and for seeds. The same investigations were continued at Soroksár, 1966, with six onion varieties grown from seeds + Makó onion sets. Five tumblers and one yellow-dish were placed in the plots of each variety. The examinations took place between 18th May and the end of August.

The obtained results are contained in Tables 1—4, indicating:

Table 1

Number of flies of Dizygomyza cepae (Her.) captured by earth-traps at Makó, 1966

Date	Onion sets		Onion for consumption		Onion grown for seeds	
May	I	22	III	11	V	11
June		43		47		24
July		3		14		16
		68		72		51
May	II	13	IV	12	VI	8
June		55		37		28
July		14		14		14
		82		63		50
May	1	—	6	5	11	1
June		15		15		11
July		6		6		6
		21		26		18
May	2	—	7	10	12	1
June		13		9		9
July		1		6		3
		14		25		13
May	3	—	8	3	13	2
June		10		10		11
July		3		10		5
		13		23		18
May	4	—	9	4	14	1
June		6		9		5
July		5		4		4
		11		17		10
May	5	—	10	1	15	1
June		10		9		7
July		1		8		4
		11		18		12
Total		220		244		172

I—VI = yellow-dishes
1—15 = tumblers

Table 2

Number of flies of Dizygomyza cepae (Her.), captured by earth-traps at Makó, 1966, given in pentodes

Date	Onion sets							Onion for consumption							Onion grown for seeds							
	I.	II.	1.	2.	3.	4.	5.	III.	IV.	6.	7.	8.	9.	10.	V.	VI.	11.	12.	13.	14.	15.	
18—22 V.	7	8						4	4	3	5	2	2	1	4	2						
23—27 V.	15	5						6	8	2	5	1	2		7	6	1	1	2	1	1	
28 V.—1 VI.		1	1		1			2														
2— 6 VI.	8	9	6	1	1	1	3	6	2	1		2			1	2	1	1		1		
7—11 VI.	9	20	4				1	16	14	5	4	2	2	2	9	12	4	3	3	1		
12—16 VI.	4	10	2	8	6	3	1	12	11	9	2	3	4	3	8	7	5	4	3	2	4	
17—21 VI.	6	10		3			4	7	7		2	3	3	2	2	2		1	2		1	
22—26 VI.	5	5		1				4	3		1			2	3	5	1		3	1	2	
27 VI.—1 VII.	11		1		2	2	1	1							1							
2— 6 VII.	1	7	4		2	2		7	9	2	2	4	3	5	8	7	3	2	3	3	4	
7—11 VII.	2	3	2	1	1	2	1	6	4	4	4	6	1	3	6	6	3	1	2	1		
17—21 VII.																						
22—26 VII.																						

I—VI = yellow-dishes
1—15 = tumblers

Table 3

Number of flies of Dizygomyza cepae (Her.), captured by earth-traps at Makó, July 1967

Onion grown for seeds		Onion grown for consumption		Onion grown for seeds	
I	11	III	6	V	18
II	10	IV	24	VI	13
1	2	5	—	9	—
2	1	6	—	10	—
3	1	7	—	11	1
4	2	8	1	12	—
	27		41		32

I—VI = yellow-dishes
1—12 = tumblers

1. number of the adults of onion leaf-miner captured by yellow-dishes is higher than that of the ones captured by tumblers (Tables 1 and 4);

2. at Makó the adults of *D. cepae* were observed between May and mid-July (Table 2), while at Soroksár they occurred till the end of July, but on 22nd and 23rd August one adult could also be collected;

3. the number of *D. cepae* adults increased in June.

Table 4

Number of flies of Dizygomyza cepae (Her.), captured by earth-traps on different varieties of onion at Soroksár, 1966

Date	Varieties of onion													
	Braun-schweigi		Makói		Fehér csemege		Zittaui		Vertus		Téli sarjadék		Makói onion sets	
May	I	2	II	2	III	3	IV	3	V	2	VI	3	VII	2
June		1		1		3		2		1		—		4
July		—		—		—		—		—		—		3
August		—		—		—		—		—		—		—
		3		3		6		5		3		3		9
May	1	1	6	1	11	1	16	—	21	2	26	2	31	2
June		1		1		—		—		—		2		—
July		—		1		—		—		1		1		—
August		—		—		—		1		—		—		—
		2		3		1		1		3		5		2
May	2	1	7	—	12	2	17	2	22	2	27	—	32	2
June		2		1		1		1		—		—		—
July		2		—		—		4		2		2		2
August		1		—		—		—		—		—		—
		6		1		3		7		4		2		4
May	3	2	8	1	13	1	18	4	23	2	28	2	33	2
June	1			1		—		1		—		—		—
July		—		—		2		1		1		1		—
August		—		—		1		—		—		1		—
		3		2		4		6		3		4		3
May	4	1	9	2	14	1	19	2	24	3	29	1	34	—
June		—		—		1		—		—		1		—
July		—		—		—		1		1		—		—
August		—		—		—		—		—		—		—
		1		2		2		3		4		2		—
May	5	2	10	1	15	2	20	3	25	4	30	2	35	2
June		—		—		1		—		1		—		2
July		1		—		1		—		1		—		1
August		—		—		—		—		—		—		—
		3		1		4		3		6		2		5
Total		18		12		20		25		23		18		23

I—VII = yellow-dishes
1—35 = tumblers

2. Larva and pupation

1. In 1965 and 1966 larvae were collected at Soroksár and the pupation and emergence of adults were studied under laboratory conditions. The results are shown in Table 5.

Table 5

Pupation and emergence of Dizygomyza cepae (Her.) from collected larvae, under laboratory conditions

Date of collecting larvae		Beginning of pupation		Emergence of adults	
1965	1966	1965	1966	1965	1966
2, VI	3, VI	23, VI	28, VI	21, VII	29, VII
17, VI	17, VI	7, VII	5, VII	3, VIII	8, VIII
9, VII	8, VII	24, VII	27, VII	29, VIII	21, VIII
23, VII	22, VII	21, VIII	25, VIII	25, IX	3, X

From the results shown in Table 5, we can conclude that the larval stage lasted 15—29 days in 1965 and 27—36 days in 1966. The period of pupation ranged from 26 to 35 days in 1965, and from 24 to 38 days in 1966.

2. 300 onion leaves were collected at three different dates and the mines made by larvae were observed. This test showed 58 per cent larva occurrence in the middle third of the leaves, while 31 per cent of the larvae were found in the lower third, and 11 per cent in the upper third.

3. In another test it was established that the larvae pupated at 3—7 cm depth in the soil.

3. Effect of autumn sowing

An experiment was conducted in 1965 at two locations (Soroksár and Buda Plantation) to study the effect of autumn sowing on the rate of infection by onion leaf-miner during the next year (1966). At the two sites six varieties of onion were sown in randomized design with four replications in three different times (August, September, October). The results are presented in Tables 6 and 7.

The results indicate that the onion plants sown in October were more seriously damaged than those sown in September. It can also be concluded that the variety "Fehér Csemege" was more susceptible to infection by *D. cepae* than the others which were also sensitive.

4. Evolution of infection

In 1966 a field experiment was conducted at Soroksár on different onion varieties, each with four replications. Attacked plants were evaluated during the period from May to September to obtain a real picture of the evolution of onion leaf-miner infection and to test the susceptibility of onion varieties at the same time. The results are reported in Table 8.

Table 6

The 1966 results of testing the injury caused by Dizygomyza cepae (Her.) to onion varieties sown in autumn, 1965

Soroksár

Onion varieties	Attacked onion plants (in per cent)		
	Date of sowing		
	August	September	October
1. Braunschweigi	0	20	20
2. Makói	0	0	20
3. Fehér csemege	20	25	30
4. Zittaui	0	30	30
5. Vertus	30	30	0
6. Téli sarjadék	0	10	30

Table 7

The 1966 results of testing the injury caused by Dizygomyza cepae (Her.) to onion varieties sown in autumn, 1965

Buda

Onion varieties	Attacked onion plants (in per cent)		
	Date of sowing		
	August	September	October
1. Braunschweigi	12	18	23
2. Makói	7	13	18
3. Fehér csemege	21	36	42
4. Zittaui	8	12	12
5. Vertus	28	25	34
6. Téli sarjadék	14	22	17

Table 8

Percentage infection by D. cepae (Her.), in different varieties of onion

Soroksár, 1966

Varieties	Date of testing				
	May	June	July	August	September
1. Braunschweigi	12	16	20	20	24
2. Makói	20	24	32	28	36
3. Fehér csemege	24	20	28	32	32
4. Zittaui	4	4	8	8	4
5. Vertus	12	16	16	20	24
6. Téli sarjadék	24	28	32	36	40
7. Makói onion sets	12	16	24	24	28

According to the results in Table 8 it can be established that there is no leaf-miner resistant variety. Probably the variety "Zittaui" forms an exception, because its injury in the whole vegetative period was less than 10 per cent. At the same time the rate of infection ranged from 4 to 36 per cent.

In another recording at Makó in 1966 the incidence of infection by *D. cepae* reached 60—70 per cent, and increased up to a maximum of 100 per cent in some localities.

Fig. 2. Plant leaves were infected by onion leaf-miners

5. Influence of soil water level

It has been found that the water level of the soil has an important role in the incidence of infection, since the infection was far more severe in case of high water level than in low. In the locality where the water level of soil was (1.5—2 m) deep the infection was 25 per cent in May, 50 per cent in June and 73 per cent in July. In another locality where the water level was deeper (3—4 m) the infection was 5 per cent in May, 15 per cent in June and 28 per cent in July.

It is interesting to mention that in case of onion grown for seeds all the plant leaves were infected by onion leaf-miners, but the carrier of flower remained uninfected (Fig. 2).

6. Chemical control

Experiments on the chemical control of *D. cepae* were also conducted. Two sprays from the end of June at two-week intervals, with 0.02 per cent Dimecron 100, or 0.2 per cent Tribuphon E.C. 50, or 0.075 per cent Liro-Malathion gave good control.

Discussion

The earth-traps method is reliable to study the population of *D. cepae*, especially the yellow-dishes. The adults of onion leaf-miner occurred from May until the end of July. The month of June is considered to be the time of population culmination.

The larva stage of *D. cepae* lasted from 15 to 29 days in 1965 and 27—36 days in 1966. The period of pupation was between 26—35 days in 1965, and 24—38 days in 1966. The pupation took place at 3—7 cm depth in the soil. The majority of larvae (58 per cent) was found in the middle third of the leaf.

Onion plants sown in October were more seriously damaged than those sown in September. The variety "Fehér csemege" was more susceptible to infection by *D. cepae* than the other varieties which were also sensitive, only the variety "Zittaui" forms an exception because in the whole vegetative period the damage was less than 10 per cent.

The rate of infection was 4—36 per cent at Soroksár, 1966, but it reached 60—70 per cent and increased up to a maximum of 100 per cent in some localities of Makó in the same year (1966).

The water level of soil plays some role in the evaluation of infection because in the of case high water level the infection was more severe than in low.

In case of onion grown for seeds the leaves were infected by onion leaf-miners but the carrier of flower was not, due to its thickness.

REFERENCES

EICHLER, W. (1950): Zwiebelminierschädlinge in Mitteldeutschland (1949). Nachrichtenbl. deutsch. Pflanzenschutzd., **4,** 3/4.

HERING, E. M. (1927): *Agromycidae.* In: F. Dahl: Die Tierwelt Deutschlands. **6,** 172.

HERING, E. M. (1956): Schnelle Unterartbildung bei *Cephalomyza cepae* (Hg.) (Dipt. Agromyz.). Deutsche Entomologische Zeitschrift, **3,** 258—261.

KALANDADZE, L. P.—SHAVKATSISHVILI, L. D. D. (1958): Contributions to the study of several species of flies as pests of vegetables in Georgia. Soobshch. Akad. Nauk gruz. SSR., Tiflis, **21,** 319—326.

NIETZKE, G. (1953): Beiträge zur Biologie und Epidemiologie der Zwiebelminierfliege *Dizygomyza cepae* Her. Z. ang. Ent., **35,** 249—270.

STELLWAAG, O. (1931): Zwiebelschädlinge in der Südpfalz. Winzer. u. Bauer, Beilage z. Landauer Anzeiger. 4. 7. 31.

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THE EFFECT OF CAPTAN, ZINEB AND DITHIANON ON THE PROTECTION OF APPLE TREES TO VENTURIA INAEQUALIS

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Due to the effect of nitrogen-containing organic fungicides the basic contamination caused by *V. inaequalis*, amounting to 34—51 per cent on leaves and to 60—85 per cent on fruits, decreased to the fourth and twentieth part respectively in two state farms. In comparison to the 58—85 per cent toxicity (scorching) of fruits raised by copper oxychloride, spraying with captan (Orthocid) and zineb (Aspor) did not set off fruit toxicity on either of the examined three apple varieties (Jonathan, Golden delicious, Starking). Dithianon (Delan) brought about reticular spottedness on the fruits of the most sensitive apple variety (Golden delicious) with a frequency of about 47 per cent; therefore dithianon cannot be applied to this variety. On the leaves of the examined apple varieties neither of the nitrogen-containing organic fungicides engendered spottedness of phytotoxic origin. The red covering colour, very important from the aspect of commercial value, was induced by dithianon to 98—99 per cent on the major part of fruits. Due to this highly advantageous side-effect, dithianon should be used to a large extent in the future for the protection of Jonathan varieties against the infection by *V. inaequalis*. Compared with the controls the examined three fungicides stimulated the growth of shoots by 44 to 64 per cent till the end of the vegetative stage (31. VIII). This favourable side-effect justifies also the application of nitrogen-containing organic fungicides in apple orchards. The effect of zineb is exceedingly short-lived, so sprayings with it in turns of 8 to 10 days are not satisfactory. In case of a relatively high-degree basic infection captan is disproportionately less effective against *V. inaequalis* in relation to dithianon, therefore, the latter should be preferred for the protection of the Jonathan and Starking varieties.

Introduction

V. inaequalis attacks equally the leaves and young developing fruits of apple trees. From the measures of control biological and agricultural practices as well as breeding for resistance are only possibilities, while satisfactory results can almost exclusively be expected from chemical protection today. According to recent commercial standards only fruits entirely free of *V. inaequalis* infection must be marketed. To promote the successful preventive and curative chemical control, continually new and increasingly effective products are placed on the market. In Hungary, on the basis of three-year experiments, under the trademark Orthocid a chemical containing captan as agent was introduced on large-scale in the fourth year and has proved its satisfactorily favourable effect in practice as it was reported circumstantially in previous papers of the authors (Csorba—Dancs-Rozsnyay 1963, 1964;

DANCS-ROZSNYAY—CSORBA 1966). The application of this fungicide yielded good results also in other host-parasite relations, so against the powdery mildew of vine (LEHOCZKY 1964), too. According to practical data (DANCS-ROZSNYAY—CSORBA 1966) in case of relatively high basic infection the produce Aspor containing 80 per cent zineb, afforded only moderate protection. Delan, a chemical containing dithianon as agent, was applied as a new fungicide, and, considering the strikingly favourable results in the course of preliminary experiments, also its side-effects were thoroughly studied. To assess critically the classic control measures, beside modern organic fungicides containing nitrogen also the produce Kuprikol containing copper oxychloride was tested. The untreated control plots served for the establishment of basic contamination. Experimental results achieved in the characterization of infective processes and the biochemical effect of the fungicides were published in other papers (DANCS-ROZSNYAY—CSORBA—FERENCZ—POZSÁR 1967; DANCS-ROZSNYAY—FERENCZ—POZSÁR 1968).

Material and Method

Apple varieties. For the experiments 5- to 10-year-old fruiting specimens of the apple varieties Jonathan, Golden delicious and Starking (*Malus pumila* Mill.) grafted on EM IX stock have been chosen, because the latter is very susceptible to the infection by *V. inaequalis*, Golden delicious sensitive to fungicides and Jonathan is cultivated in the largest scale.

Products. It has been intended to find out experimentally also the degree of phytotoxicity, in addition to the valuation of the protective and curative effect respectively. The structural formula and some other data of nitrogen-containing organic fungicides are given below.

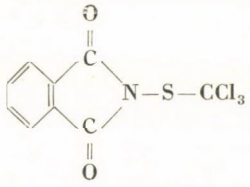
Sprayings were performed first at budding (13. IV), for the second time at red bud state (23. IV), for the third time at flowering (8. V), for the fourth time after petal drop (22. V) and subsequently still seven times at the following dates: 7. VI, 19. VI, 30. VI, 8. VII, 20. VII, 7. VIII and 27. VIII. Due to simultaneous treatments the effect of the four chemicals could clearly be evaluated in the comparisons. Captan was applied as a 0.3 per cent and zineb as a 0.2 per cent solution in all treatments. From dithianon a solution of 0.075 per cent concentration was prepared for the first two sprayings, in the third and subsequent ones the concentration amounted to 0.05 per cent. Copper oxychloride had a concentration of 0.5 per cent in the first, of 0.2 per cent in the second and of 0.1 per cent in the subsequent treatments.

The infection of fruits by *V. inaequalis* was established immediately after picking. Within each treatment 10×100 apples were examined and specimens showing a single scab only were ranged with the "infected" category. This procedure yielded directly percentual data of infection expressed as the arithmetic mean of the results from ten replications.

The infection of leaves was assessed in three cases. The first examination was carried out, when in the untreated control plots the first symptoms of infection appeared (15. VI). Subsequent observations were made for the second time after 6 weeks (30. VII) and for the third time at the termination of shoot growth (31. VIII). The contamination of leaves was qualified by examining 100 leaves each from 10 trees in each treatment. Independently of the number of spots found on the leaves, already a single one sufficed to qualify the leaf as "infected". The frequency of infection was expressed in per cent of the means.

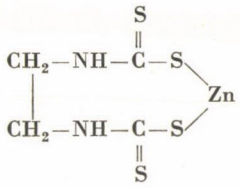
Damages by scorching. Phytotoxicity of fruits and leaves was assessed similarly to contamination. All leaves showing but a single necrotic spot due to the damage by chemicals were qualified as scorched. On fruit the spraying-caused damage, the scorching (fruit toxicity), was established immediately after picking, so that all fruits suberized on the eighth of their surface were classified as damaged. Beside Jonathan, scorching was also established on the varieties Golden delicious and Starking, with respect to their different sensitivity to chemicals.

Fruit colouration. The degree of colouration, this important criterion of the commercial value of fruits, was determined with the help of a practical colour scale: by picking 100



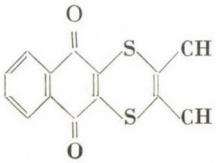
Orthocid Chemie-Wien, Austria

captan (N-trichloromethyl-thio-tetrahydrophthalimide)



Aspor Montecatini, Italy

zineb (zinc-ethylene-bis-dithiocarbamate)



Delan Merck, German Federal Republic

dithianon (2,3-dicarbonitrile-1,4-dithioantraquinone)

copper oxychloride

Kuprikol Spolana, Czechoslovakia

apples each from 10 trees and qualifying them according to their basic (green) and covering (red) colour. The red-coloured specimens were divided into two groups: showing the covering colour to a degree either less or more than 50 per cent, respectively. All fruits without covering colour were classified as green.

Longitudinal growth of shoots. The effect of the chemicals on the longitudinal growth of shoots was established in the characteristic stage of vegetative growth, as done by LEHOCZKY (1964) for the valuation of fungicides in vineyards. The average length of shoots — as the mean of 100 shoots each from 10 trees — was measured first, when the primary symptoms of infection by *V. inaequalis* appeared, i.e. on the 15th of June. For the second time the average length was determined on the 30th of July and the effect of chemicals on the longitudinal growth of shoots expressed as the difference of the data thus obtained. The result was related to the shoot length at the termination of vegetative growth (31. VIII).

Results

The effect of nitrogen-containing organic fungicides has been assessed with the contamination of leaves and fruits on apple trees, as it is shown by the percentual data of Table 1. It must be strictly stressed that — compared with the data found on the controls — in the Kecskemét State Farm the examined four pesticides have diminished the infection of leaves to a higher but that of the fruits to a lower degree than in the Bak State Farm.

From the three nitrogen-containing organic fungicides only dithianon has caused toxicity on the fruits of the Golden delicious variety, whereas

Table 1

The effect of nitrogen-containing organic fungicides in controlling the infection caused by Venturia inaequalis on the Jonathan apple variety

The percentual frequency of infection after treatment is compared to the data obtained with copper oxychloride

Treatment	Percentual frequency of infection after treatment			
	on fruits in the State Farm		on leaves in the State Farm	
	Bak	Kecskemét	Bak	Kecskemét
Control	60.0	85.0	51.0	33.8
Captan	5.0	20.0	4.0	2.6
Zineb	3.0	23.0	9.0	6.9
Dithianon	2.0	17.0	3.0	5.5
Copper oxychloride	3.0	9.0	7.0	9.0

leaf toxicity has not been brought about by either of the chemicals, as it is demonstrated by the percentual data of Table 2. On the other hand, the application of the classic copper oxychloride has led to 58—85, and 8—20 per cent toxicity on fruits and leaves, respectively. These data demonstrate clearly that due to its high-grade phytotoxicity copper oxychloride lags considerably behind the modern organic fungicides, especially as to their excellent side-effect.

Table 2

Percentual phytotoxicity caused by nitrogen-containing organic fungicides and copper oxychloride

Treatment	Percentual phytotoxicity caused by the treatments on					
	Jonathan		Golden delicious		Starking	
	fruit	leaves	fruit	leaves	fruit	leaves
Captan	1	0	0	0	0	0
Zineb	0	0	0	0	0	0
Dithianon	0	0	47	0	0	0
Copper oxychloride	67	16	85	20	58	8

In the development of the covering colour, very desirable from the aspect of commercial value, dithianon has proved to be the most favourable, the effect of captan and zineb being fairly lower. The pertaining experimental results are presented in Table 3. Spraying with dithianon has induced fruit reddening (extending to more than 50 per cent of the apple surface) in 98 to 99 per cent on the Jonathan variety. This is — in addition to the satisfactorily high-grade fungicidal impact — such an excellent side-effect that justifies the broader application of chemicals containing dithianon as agent.

Table 3

The effect of nitrogen-containing organic fungicides inducing the development of the covering colour (compared with the green basic colour) on Jonathan apples at the time of fruit picking (September 28)

The data show the percentual quantity of coloured fruits in State Farm

Treatment	Green basic colour covering		Red colour covering less than 50%		Red colour covering more than 50%	
	Bak	Kecskemét	Bak	Kecskemét	Bak	Kecskemét
Control	4	5	20	30	76	65
Captan	2	0	8	6	90	94
Zineb	1	3	2	8	97	89
Dithianon	0	0	1	2	99	98

Table 4 demonstrates the effect of the examined three nitrogen-containing organic fungicides on the longitudinal growth of shoots in the first stage of control and at the end of the vegetative phase. The stimulation exerted on average longitudinal shoot growth amounts to 44—64 per cent in the stage of shoot ripening and may be, therefore, considered as a very favourable side-effect, in addition to the convenient fungicidal activity. The manifestation

Table 4

Averages of longitudinal shoot growth (in cm) of Jonathan apple trees, induced by nitrogen containing organic fungicides. Surveys carried out in the period of June 15—July 30 and at the end of the vegetative phase (August 31)

Treatment	Average longitudinal shoot growth in the period June 15—July 30	Average length of shoots on August 31
Control	7.75	15.85
Captan	8.80	26.10
Zineb	10.71	22.90
Dithianon	12.04	24.61

of side-effects generally reveal that the chemicals induce peculiar biological stimulation, in consequence of which it must be supposed that the products of their breakdown may undoubtedly be considered as metabolites either directly or indirectly.

Discussion

Fungicidal mode of action. In connection with the biochemical mode of fungitoxicity of the examined products it may generally be said that they exert their action by inhibiting the irreversible redox transformation of the

sulphhydryl groups, as pointed out by THORN—LUDWIG (1962) in their comprehensive work. In the parasite the quantity of sulphhydryl groups is relatively larger, which partly explains the specific mode of action.

The fungitoxicity has been described in detail by CREMLYN (1963), proving directly that the trichloromethylmercaptan group (—S—CCl_3) promotes the penetration of the chemical into the fungal body and that the diketoazide (—CO—NR—CO—) may be looked upon as a product of breakdown, to the fungitoxically active group. Dealing in several papers with the fungitoxicity of *captan* RICHMOND—SOMERS (1962a, 1962b, 1963, 1966) as well as SOMERS—RICHMOND (1962) have concluded from their investigations on this chemical labelled with radioactive sulphur that due to its effect the quantity of sulphhydryl groups diminishes by 35 per cent in the spores. OWENS—BLAAK (1960a, 1960b), LUKENS (1963, 1964) as well as LUKENS—SISLER (1958) have explained similarly with the sulphur metabolism of fungi the specific fungitoxicity of captan. The occurrence of captan residues in foodstuffs was analytically examined by KOIVISTOINEN *et al.* (1965).

Most detailed informations on the mode of action of *zineb* were given by THORN—LUDWIG (1962) as well as by SOMERS (1962), who pointed out that ethylenethiurammonosulphide, a breakdown product of zineb, exerted the highest fungitoxic activity.

According to the micro-preparative analytical results of CZEGLÉDY-JANKÓ (1967) beside ethylenethiurammonosulphide, also ethylenethiuram-disulphide and ethylenethiocarbamide come into being during storage in humid air-space. GREWE (1965) demonstrated in connection with *V. inaequalis*, while LAFON—COUILLAUD (1953) with vine-mildew that zineb exerted its effect directly on the germination of conidium spores.

BERKER—HIERHOLZER—MOHR (1957) were the first who described the synthesis as well as the protective and curative effect of *dithianon* as a new compound of fungicidal activity on *V. inaequalis*. According to the experimental results of MOORE (1966) it has a higher protective than curative effect, and may, therefore, be considered analogous with captan and zineb, as it has been demonstrated, also in practice, by FLEMING—HIERHOLZER—MOHR (1963).

The effect of dithianon is displayed in Table 5 on the basis of results gained in glasshouse experiments by MOORE (1966). Applying preventively and in adequate concentration, this chemical diminishes the infection by 81—90 per cent, while the curative effect amounts at most to 50 per cent. According to experimental results of the present authors it has increased the scorching of Golden delicious fruits by 47 per cent, so due to the high-grade sensitivity of this variety dithianon cannot be suggested for its protection. However, it must be taken into consideration that in the development of fruit toxicity a great number of factors participate, as shown by KREMER

Table 5

The concentration-depending protective and curative effect of dithianon against the infection by V. inaequalis, according to the glasshouse experiments of Moore (1966)

Percentual decrease of infections	Protective	Curative
	concentration (in per cent)	
Less than 25%	—	0.05—0.025
25—50	—	0.2 —0.1
51—60	0.025	—
61—70	0.05	—
71—80	0.1	—
81—90	0.2—0.15	—

(1963). The spottedness of Golden delicious fruits is brought about by the joint effect of nine factors in which scorching by the chemical is only one of them.

In some cases the fungicidal effect of *copper oxychloride* lags behind that of selectively specific organic fungicides of high activity. HISLOP (1966) pointed out that inorganic copper became diluted secondarily from the surface of leaves, but between the quantity of the copper content in the cell-sap and the infection (and damage respectively) caused by microorganisms no correlation could be evidenced.

Among the numerous side-effects of fungicides also the toxicity affecting pollen germination and fertilization respectively are to be mentioned in brief. This problem was approximated by several authors (ZAHOV 1965, LIEBSTER 1965). In recent years the method of spraying before and in the period of flowering has been gradually gaining ground which particularly justifies experimental testing. The fertilization ratio related to the number of flowers is influenced only to a very low degree by organic fungicides. Results of experiments carried out by the authors will be published in another paper (DANCS-ROZSNYAY—KISS 1968).

Qualification of the products. Out of the examined chemicals *Orthocid* proved to be of very satisfactory effect in practice for many years, and through it the protection against *V. inaequalis* could successfully be solved.

Two-year small-plot experiments and subsequent large-scale tests carried out with *Delan* showed that this fungicide exerted a high-grade preventive and moderate curative effect, and, in addition, is also suitable to ward off storage diseases. Therefore and due to many favourable side-effects Delan will play an increasingly important role in the control of *V. inaequalis*. Its only disadvantage is the scorching of white-skinned apples (Golden delicious), so it cannot be applied in orchards of mixed plantation especially in periods, when the danger of

scorching is ahead. Delan has excellent side-effects (induces the covering colour, shoot growth stimulator) which underline its usefulness.

According to practical results *copper oxychloride* (Kupricol) can generally be applied for a very limited period only. Its fungicidal activity is of an acceptable degree, but in consequence of other side-effects (phytotoxicity, fruit scorching) it cannot be suggested for the protection of certain fruits, and may at most be applied till flowering. For this reason copper oxychloride becomes gradually ousted from plant protection practice.

For the control of *V. inaequalis*, *Aspor* can be proposed only in combination with Orthocid or Delan. According to the authors' experience the effect of Aspor is very short-lived and, therefore, highly disadvantageous in the practical plant protection of apple orchards. The requirements of large-scale practice can be satisfied only by plant protectants that exert even in spraying turns of 8 to 10 days excellent fungitoxicity, and in addition, favourable side-effects without any phytotoxicity.

REFERENCES

Berker, J.—Hierholzer, O.—Mohr, G. (1957): Dithianon, a new organic compound with fungicidal properties. E. Merck A. G., Darmstadt.

Cremlyn, R. J. (1963): Review of protectant fungicides. Internat. Pest Control. **5,** 10—17.

Czeglédy-Jankó, G. (1967): Etilénbiszditiokarbamátok bomlástermékeinek rétegkromatografiás meghatározása és néhány vizsgálat az in vitro bomlásra (Layerchromatographical determination of the breakdown products of ethylene-bis-dithiocarbamate and some examinations on the in-vitro breakdown). Manuscript.

Csorba, Z.—Dancs-Rozsnyay, Zs. (1963): Védekezés az almafa-varasodás ellen (Control of scabs in apple trees). Kert. és Szől. Tudományos Tanácsadója. **17,** 11.

Csorba, Z.—Dancs-Rozsnyay, Zs. (1964): Újabb eredmények az almafa-varasodás elleni védekezésben (Recent results in the control of apple scabs). Növényvédelem Időszerű Kérdései, **2,** 15—22.

Dancs-Rozsnyay, Zs.—Csorba, Z. (1966): Újabb szerves gombaölő szerek és hatástartamuk az almafa-varasodás ellen (New organic fungicides and the duration of their activity in controlling apple scabs). Tud. Ért. Budapest. **1,** (11): 1—19.

Dancs-Rozsnyay, Zs.—Csorba, Z.—Ferencz, V.—Pozsár, B. I. (1967): Radiobiologische Wertung der Anwendung von Fungiziden gegen die Infektion von *Venturia inaequalis*. Agrártud. Közl., **26,** 313—325.

Dancs-Rozsnyay, Zs.—Ferencz, V.—Pozsár, B. I. (1968): Effect of captan, zineb and dithianon on the $^{14}CO_2$ fixation by apple leaves. Manuscript.

Dancs-Rozsnyay, Zs.—Kiss, A. (1968): The effect of sprayings carried out in flowering on fruit setting). Manuscript.

Flemming, H.—Hierholzer, O.—Mohr, G. (1963): Dithianon, eine organische Verbindung mit breiter fungizider Wirkung. Z. Pflkrankh. u. Pflschutz, **70,** 4—11.

Grewe, F. (1965): Rückblick auf 25 Jahre Fungizidforschung. Pflschutz Nachr. Bayer, **18,** 45—74.

Hislop, E. C. (1966): The redistribution of fungicides on plants. II. Solution of copper fungicides. Ann. appl. Biol., **57,** 475—489.

Koivistoinen, P.—Karinpää, A.—Könönen, M.—Rovine, P. (1965): Magnitude and stability of captan residues in fresh and preserved plant products. J. Agric. Food Chem., **13,** 468—473.

Kremer, F. W. (1963): Über Ursachen von Fruchtberostungen bei der Sorte Golden delicious. Pflschutz Nachr. Bayer **16,** 17—22.

LAFON, J.—COUILLAUD, P. (1953): Essais de fongicides organiques dans la lutte contre le Mildiou de la Vigne. C. R. Acad. d'Agr. France, **53,** 744—747.
LEHOCZKY, J. (1964): Influence of the fungicides on the green- and dry matter weight and the total chlorophyll content of grape-vine leaves. Kísérletügyi Közl., **57/C,** 73—85.
LIEBSTER, G. (1965): Ergebnis 2jähriger Untersuchungen über den Einfluss mehrerer während der Blüte ausgebrachten Fungizide auf Junifruchtfall und Fruchtbehang beim Apfel. Z. Pflkrankh. und Pflschutz, **72,** 325—344.
LUKENS, R. J. (1963): Thiophosgene split from captan by yeast. Phytopathology, **53,** 881.
LUKENS, R. J. (1964): The sulfur-depletion of cells by captan. Phytopathology, **54,** 881—882.
LUKENS, R. J.—SISLER, H. D. (1958): Chemical reactions involved in the fungitoxicity of captan. Phytopathology, **48,** 235—244.
MOORE, M. H. (1966): Glasshouse experiments on apple scab. II. Direct and translocated fungicidal activity. Ann. appl. Biol., **57,** 451—463.
OWENS, R. G.—BLAAK, G. (1960a): Site of action of captan and dichlone in the pathway between acetate and citrate in fungus spores. Contr. Boyce Thompson Inst., **20,** 459.
OWENS, R. G.—BLAAK, G. (1960b): Chemistry of the reactions of dichlone and captan with thiols. Contr. Boyce Thompson Inst., **20,** 475—497.
RICHMOND, D. V.—SOMERS, E. (1962a): Studies on the fungitoxicity of captan. I. The structural specificity of captan and six n-trichloromethylthio analogues. Ann. appl. Biol., **50,** 33—44.
RICHMOND, D. V.—SOMERS, E. (1962b): Studies on the fungitoxicity of captan. II. The uptake of captan by conidia of *Neurospora crasse.* Ann. appl. Biol., **50,** 45.
RICHMOND, D. V.—SOMERS, E. (1963): Studies on the fungitoxicity of captan. III. Relation between the sulfhydryl content of fungal spores and their uptake of captan. Ann. appl. Biol., **52,** 327—336.
RICHMOND, D. V.—SOMERS, E. (1966): Studies on the fungitoxicity of captan. IV. Reactions of captan with cell thiols. Ann. appl. Biol., **57,** 231—240.
SOMERS, E. (1962): Mechanisms of toxicity of agricultural fungicides. Sci. Progr., **50,** 218—232.
SOMERS, E.—RICHMOND, D. V. (1962): Translocation of captan by broad bean plants. Nature, **194,** 1194.
THORN, G. D.—LUDWIG, R. A. (1962): The dithiocarbamates and related compounds. Elsevier Amsterdam.
ZAHAROV, T. — Захов, Т. (1965): Проскане на овостник дървета през време на по лини кофтерес. Природа, София, **5,** 102—105.

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STUDIES ON POD DEVELOPMENT IN THREE GROUNDNUT (ARACHIS HYPOGAEA L.) TYPES*

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The effect of flowering and pegging zone environment on fruit development was studied in three types of cultivated groundnuts. The groundnut types displayed different response to environmental conditions in the pegging zone. Nutrients were observed to translocate from the root system into the developing pod and proved to be sufficient for normal pod development in all three types studied.

Introduction

Many comprehensive studies of the reproductive stage of the principal cultivated types of *Arachis hypogaea* have been performed in recent years, and have clarified this stage of development considerably (SHIBUYA 1935, SMITH 1950). It is known that groundnut types differ in their branching and flowering patterns in addition to some other morphological features (GREGORY—SMITH—YARBROUGH 1961, SMITH 1950).

SHIBUYA (1935) reported that the Virginia Bunch type generally flowers progressively from the basal branch to the upper branches and from the base of the respective branches to their tips. Later work by EMERY (1963), EMERY *et al.* (1968) and GUPTON *et al.* (1968) established a more exact mapping of the flowering pattern of the Virginia type varieties. The effect of environmental conditions in the pegging zone upon pod formation has also been investigated (WALDERON 1918), but not in regard to probable differences between varieties. The purpose of the present work was to study the effect of flowering and pegging zone environment upon fruit development in three principal types of cultivated groundnuts.

Materials and Methods

Seeds of three groundnut types: Virginia Bunch Improved, Valencia and Spanish, were planted in 50-liter plastic containers filled with fertile alluvialic soil on May 1st in six replications. Gynophores (pegs) which appeared were tagged daily. Gynophore length and pod-weight of the corresponding gynophore were determined at harvest, which was 122 days

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after planting with the Spanish and Valencia varieties, and 145 days after planting with the Virginia Bunch Improved variety. Groups of twelve gynophores from the third to sixth nodes (counting from the cotyledonary node) of each groundnut type were treated in one of the following ways: 1. the gynophore was allowed to develop in wet vermiculite (in the absence of nutrients) and isolated from the soil in a plastic container; 2. the gynophore was prevented from penetrating into the soil and kept above soil surface; and 3. normal development in the soil.

Results and Discussion

In all three groundnut types flowering occurred gradually towards the plant tips (Fig. 1). This is in agreement with SHIBUYA's (1935) findings in regard to the Virginia Bunch type variety.

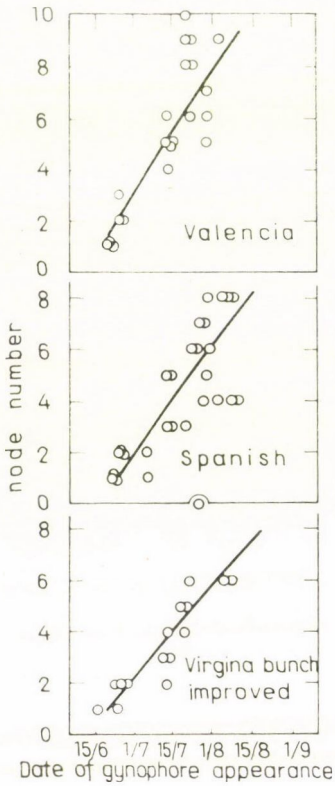

Fig. 1. The relation of the date of gynophore appearance and its placement on the plant (nodes are counted from the first cotyledonary node upwards)

The average gynophore length at different nodes in the three groundnut types is given in Fig. 2. The Virginia Bunch Improved variety had a longer average gynophore length at nodes 3—8 than did the other two varieties. Varying length of gynophores affects the pod concentration around the plant,

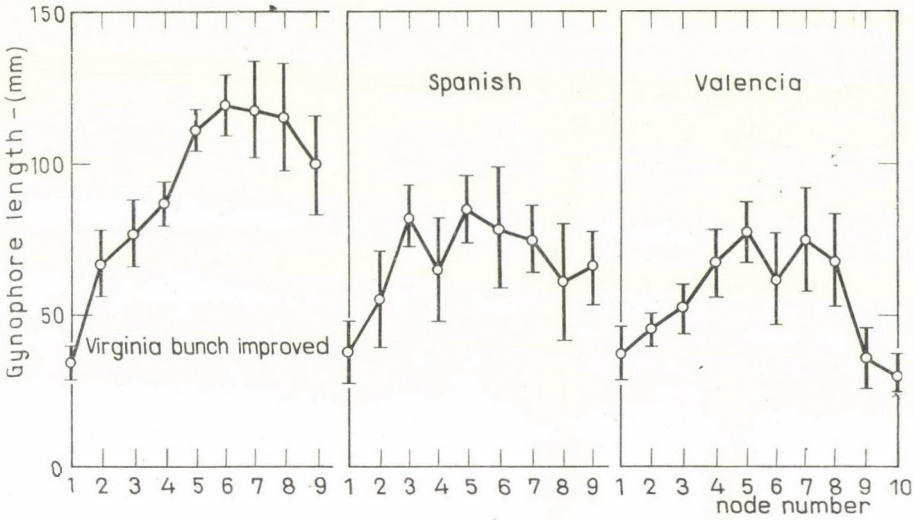

Fig. 2. Average gynophore length (± standard deviation) on the different nodes of three groundnut types

a feature which is of agrotechnical importance during harvest time. The average pod weight was affected mainly by the variety and less so by its location on the node up to the 7th, 8th and 9th nodes of the respective variety (Fig. 3). The steep decline of the average pod weight from these nodes upwards

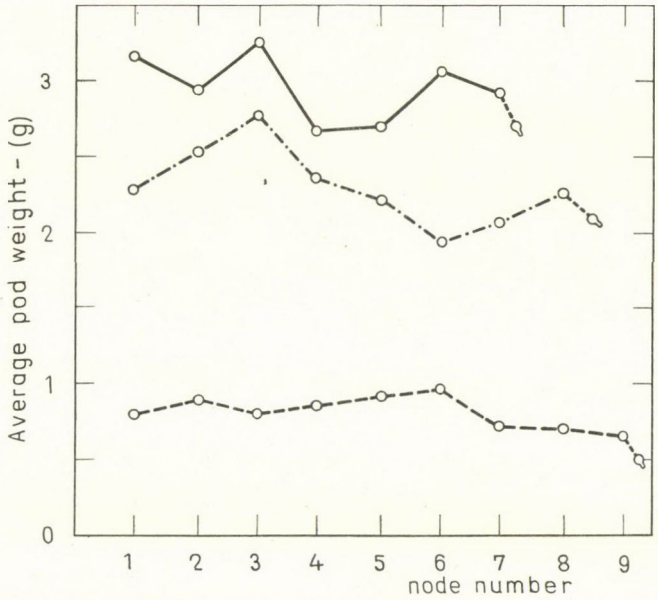

Fig. 3. Average pod-weight on gynophores from different nodes of three groundnut types (———— Virginia Bunch Improved, —.—.— Valencia, — — — — — Spanish)

is probably due to: a) the effect known as "early fruit inhibition", where the early produced fruit interferes with the development of fruits from later flowers; b) a shortened period of pod development; and c) the reduced assimilating capacity of the aging plant.

The existence of a different response of the groundnut types to environmental conditions in the pegging zone is demonstrated in Table 1.

Table 1

The effect of different treatments upon pod development in the three groundnut types

Variety	Treatment	No. of pods		No. of pegs	Normal pods (%)
		normal	"pops"		
Virginia Bunch Improved	Vermiculite	5	3	4	42
	Soil surface	1	2	9	8
	Normal	11	1	—	92
Spanish	Vermiculite	7	4	1	58
	Soil surface	—	—	12	0
	Normal	10	2	—	83
Valencia	Vermiculite	8	3	2	67
	Soil surface	5	4	3	42
	Normal	12	—	—	100

The Valencia variety showed a tendency to produce normal pods on gynophores not penetrating into the soil. Such pods had a greenish-purple colour caused presumably by both anthocyanin and chlorophyll under the influence of light. This phenomenon was also observed in commercial and other experimental plots of this variety. In the Spanish variety, on the other hand, no pods were produced on gynophores not penetrating into the soil. Pegs of the Spanish variety prevented from penetrating into the soil and kept on the soil surface attained a dark green colour and enlarged only slightly (Fig. 4).

Normal fruit was obtained in all three groundnut types in vermiculite; although in a number less than that under normal conditions. This indicates the translocation of nutrients from the root system into the developing pod and their sufficiency for normal pod development in all three types examined. Pods developed in wet vermiculite had, to a greater or lesser degree, a velvet-like covering, as observed by WALDERON (1918). This "root-hair-like" layer is supposed to absorb water and nutrients. It appears, therefore, that some contradictory results may be obtained concerning pod formation of pegs not developing under normal conditions in the soil. Such results may have been caused by the different groundnut types used in the experiment.

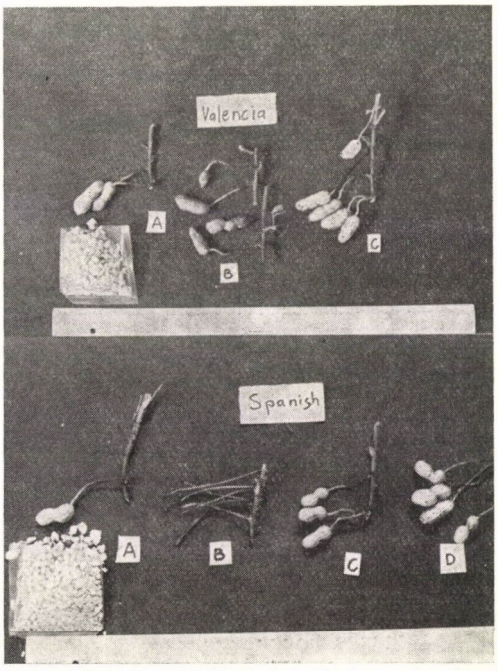

Fig. 4. Pegs of the Valencia and Spanish groundnut varieties which developed in different environments. A: in wet vermiculite; B: on the soil surface; C, D: under normal conditions in the soil

REFERENCES

EMERY, D. A. (1963): Reproductive efficiency in Virginia type peanuts. I. Differences among varieties. Proc. Peanut Improvement Working Group, Oklahoma State Univ., Stillwater, Oklahoma, 107—135.

EMERY, D. A.—GUPTON, C. L. (1968): Reproductive efficiency of Virginia type peanuts. II. The influence of variety and seasonal growth period upon fruit and kernel maturation. Oleagineux, **23,** 99—104.

GOLDIN, E.—HAR-TZOOK, A. (1966): Observations on the flowering and reproduction of groundnuts (*Arachis hypogaea* L.) in Israel. Israel J. Agric. Res., **16,** 3—9.

GOLDIN, E.—HAR-TZOOK, A. (1966): The effect of fertilization on the vegetative and reproductive development of Virginia Bunch Improved groundnuts. Oleagineux, **21,** 17—20.

GREGORY, W. C.—SMITH, B. W.—YARBROUGH, H. A. (1961): Morphology, genetics and breeding. Ch. III, 28—88. In: The peanut, the unpredictable legume. National Fertilizer Association, Washington, D. C.

GUPTON, C. L.—EMERY, D. A.—BENSON, J. A. (1968): Reproductive efficiency of Virginia type peanuts. III. Relating the time of peg placement to the branching pattern of the plant. Oleagineux, **23,** 247—250.

SHIBUYA, T. (1935): Morphological and physiological studies on the fructification of peanut *(A. hypogaea)*. Memoirs of the Fac. of Sci. and Agric. (Taihoku Imp. Univ., Formosa Japan), **17,** 1—120.

SMITH, B. (1950): *Arachis hypogaea:* Aerial flower and subterranean fruit. Am. J. Bot., **37,** 802—815.

WALDERON, R. A. (1918): The peanut (*Arachis hypogaea* L.) — its history, histology, physiology and utility. Ph. D. Thesis, University of Pennsylvania.

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CYTOGENETIC STUDY ON INTERSPECIFIC HYBRIDS OF NICOTIANA

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Within the genus *Nicotiana* hybridization between species results in sterile progeny which can be eliminated by the polyploidization of the F_1 generation. Among the produced autotetraploids only *N. bigelovii* was sterile. In the *Nicotiana* genus the only fertile diploid species hybrid is *N. paniculata* × *N. knightiana*. In the first metaphase of the meiosis always 12 bivalents develop which proves the genetic relationship between the genoms. Among the genoms of the species *N. debneyi*, *N. glutinosa* and *N. bigelovii* there is a minimum homology. The meiosis of the "new type" amphidiploids produced in our Institute is regular, and their phenotype is constant.

Introduction

Experiments on producing distant hybrids within the *Nicotiana* genus have so far led to many interesting results. Species belonging to this genus (more than 60 species are known) are self-pollinating and possess a high degree of polymorphism. Microevolution studies on the *Nicotiana* genus have been performed by many research workers (KEHR—SMITH 1952, TERNOVSKY 1962, TAKENAKA 1963, SMITH 1968). So far more than three hundred wild tobacco hybrids have been mentioned in the literature. The accumulated data were summarized by KOSTOFF (1943) and GOODSPEED (1954). Wild species of tobacco can be intercrossed relatively well, their hybrids are, however, sterile in most cases. A study on the meiosis of sterile hybrids may give clues to determine the extent of relationship between species. The method of genome analysis is usually: cytological examination of the F_1 generation of interspecific hybrids, primary determination of the extent of chromosome association in diakinesis and in the first metaphase. The greater is the homology of genomes i.e. the extent of chromosome association — the closer to each other are the two species genetically.

Materials and Methods

Experiments carried on to produce *Nicotiana* interspecific hybrids and the study of their cytogenetics were started in 1962. Our initial plant material consisted of *Nicotiana* species partly grown in our Institute and partly obtained from various foreign botanical gardens. For the cytological examinations root tips and buds of the experimental plants were fixed in Farmer's

solution (alcohol and acetic acid mixed in a ratio of 3 : 1), then washed in 70 per cent alcohol and stained with the usual aceto carmin technique. The frequency of bivalents and multivalents was calculated on examining 25 cells. Pollen fertility was determined by the ratio of stained and unstained, empty pollens (from 1500 pollens). Polyploids were produced by colchicin treatment (GYŐRFFY 1945).

Results and Discussion

Fertile amphidiploids can be produced by crossing two autotetraploids, or by treating the F_1 seedlings with colchicin. Table 1 contains autotetraploid species obtained at our Institute and used in our experiments.

Among the autotetraploids listed only the octoploid form of *N. bigelovii* proved to be of low viability; the plants were completely sterile.

Table 1

Autotetraploid forms of Nicotiana species

Subgenus	Section	Species	Chromosome number	Year of production
1. *Rustica*	*Paniculatae*	*N. paniculata* L.	48	1962 author
		N. knightiana Good	48	1964 ,,
		N. glauca Grah.	48	1952 Kovács, J.*
2. *Tabacum*	*Tomentosae*	*N. glutinosa* L.	48	1952 ,,
		N. tabacum L.	96	1952 ,,
3. *Petunioides*	*Bigelovianae*	*N. bigelovii* Watson	96	1962 author
	Suaveolentes	*N. debneyi* Domin.	96	1964 ,,

* János Kovács, Institute of Genetics of the Hungarian Academy of Sciences

In Table 2 the frequency of bivalents in interspecific hybrids produced at our Institute is shown.

Diploid interspecific hybrids show meiotic disturbances (univalents) followed by high sterility. However, sterility of hybrids can be eliminated through polyploidization.

1. *N. paniculata* (n = 12) × *N. knightiana* (n = 12) diploid and amphidiploid hybrids (Fig. 1). Both species belong to the subgenus *Rustica* and have the same chromosome karyotypes (6 median and 6 submedian chromosome pairs — GOODSPEED 1935, 1938). As in the amphidiploid 55 per cent quadrivalent frequency was found (Fig. 2), it was supposed that the species *N. paniculata* and *N. knightiana* are not only taxonomically but also genetically close to each other, and in the diploid hybrid of these species must occur a high bivalent formation. The study of the meiosis of the diploid hybrid displayed 12 bivalents in the first metaphase. Distribution of ring and open

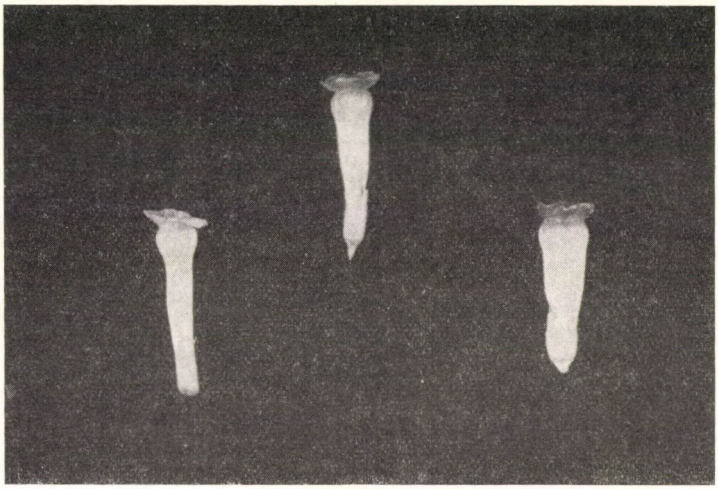

Fig. 1. On the left: *N. paniculata* tetraploid; on the right: *N. knightiana* tetraploid; in the middle: hybrid flower

Table 2

Chromosome association in the meiosis of Nicotiana interspecific hybrids

Interspecific hybrid combination	Chromosome number	First recording date and bivalent number	Year of raising F_1 and bivalent number	Mean
Diploid				
1. *N. paniculata* × *N. knightiana*	24	—	1968 12	12
2. *N. knightiana* × *N. glauca*	24	—	1963 4—9	6
3. *N. glutinosa* × *N. glauca*	24	Kostoff 1943 8—10	1962 3—7	5
4. *N. bigelovii* × *N. tabacum*	48	Christoff 1928 0—10	1963 5—9	7
5. *N. bigelovii* × *N. debneyi*	48	—	1968 0—3	1
6. *N. debneyi* × *N. glutinosa*	36	Takenaka 1963 0—8	1963 2—5	3
7. *N. debneyi* × *N. glauca*	36	—	1968 0—7	4
Amphidiploid				
8. *N. paniculata* × *N. knightiana*	48	—	1967	24
9. *N. knightiana* × *N. glauca*	48	—	1965	24
10. *N. paniculata* × *N. glutinosa*	48	—	1963	24
11. *N. glutinosa* × *N. glauca*	48	Kehr, Smith 1952	1962	24
12. *N. bigelovii* × *N. tabacum*	96	—	1964	48

bivalents in the late diakinesis was 79.5 and 20.5 per cent, respectively. Pollen fertility of the first hybrid generation was 83.9 per cent in case of full seed set. Results obtained suggest that chromosomes of the genomes of *N. paniculata*

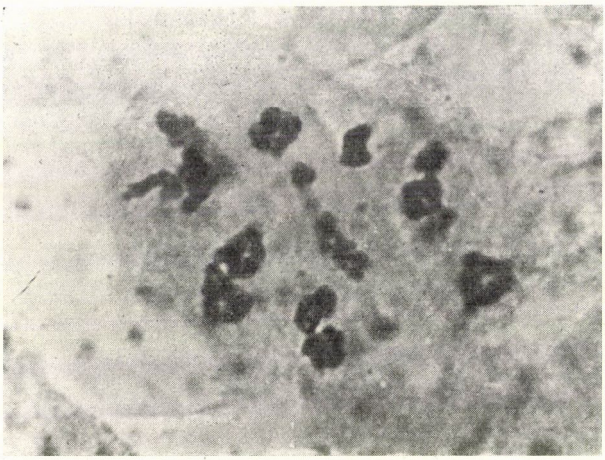

Fig. 2. Meiosis in *N. paniculata* × *N. knightiana* amphidiploid. First metaphases: 10 quadrivalents and 4 bivalents (×600)

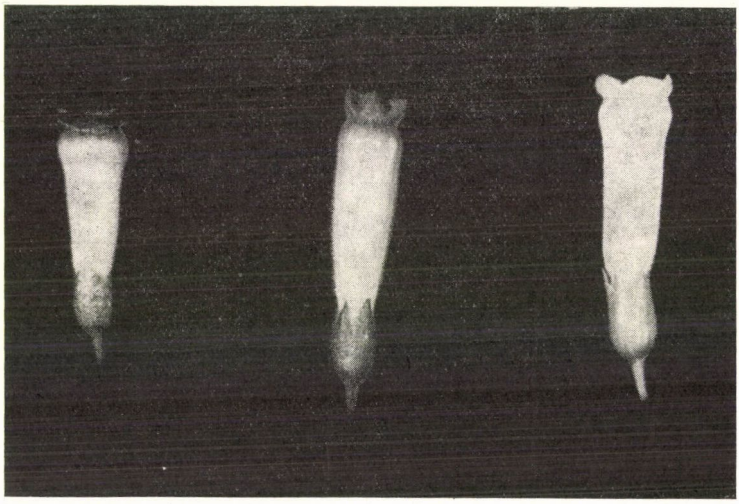

Fig. 3. Left: *N. knightiana* tetraploid; right: *N. glauca* tetraploid; middle: hybrid flower

and *N. knightiana* are probably homologous, or homoeologous. From the cytological picture, however, it cannot be determined with certainty, whether the same chromosomes are associated or whether they belong to different genomes (GYŐRFFY 1966). In any case, this interspecific hybrid has not been mentioned in the literature; further, this hybrid is fertile, thus there is a possibility of analysing the segregating generations.

2. Diploid and amphiploid combinations of *N. knightiana* (n = 12) × *N. glauca* (n = 12) have not been mentioned in the literature (Fig. 3). In diploid hybrids 4—9 bivalent formations were observed. In hybrids derived

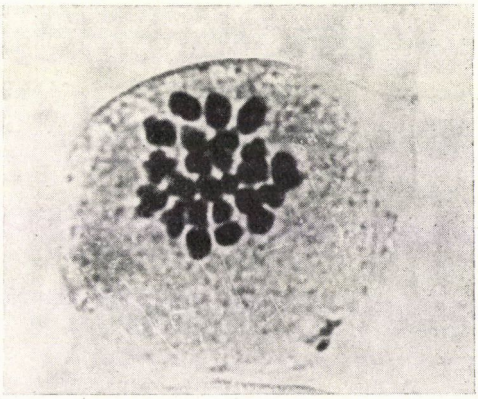

Fig. 4. Meiosis of *N. knightiana* × *N. glauca* amphidiploid with 24 bivalents (×600)

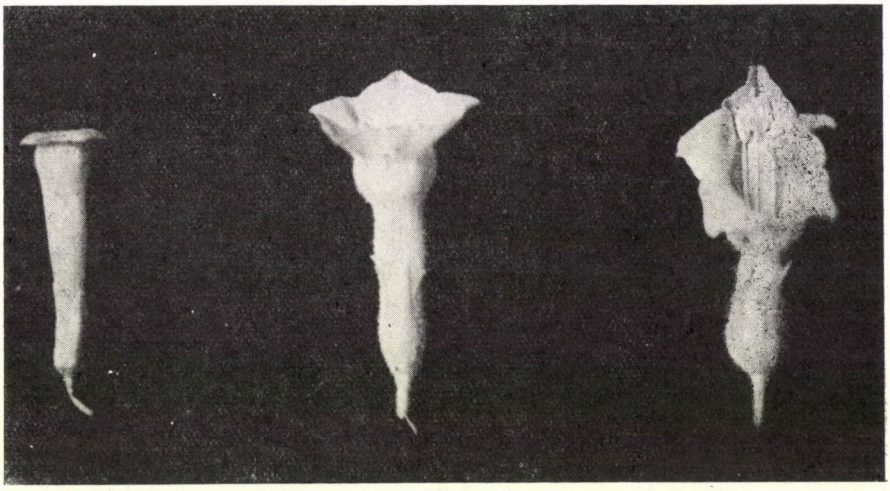

Fig. 5. Left: *N. paniculata* tetraploid; right: *N. glutinosa;* middle: hybrid flower

by crossing the species *N. paniculata* — a related species of *N. knightiana* — with *N. glauca* KOSTOFF (1943) found 3—10 bivalents, which agrees to our results. The high extent of bivalent formation suggests that in this case allosyndesis may occur, that is, several chromosomes of the genome of *N. glauca* may form homologous pairs with the chromosomes of *N. knightiana.*

Amphidiploid of the F_1 generation of *N. knightiana* × *N. glauca* obtained by colchicin treatment showed a 30 per cent pollen fertility; meiosis was regular with 24 bivalents (Fig. 4).

3. The diploid hybrid of *N. paniculata* (n = 12) × *N. glutinosa* (n = 12) was described by KOSTOFF in 1943. The author observed 2—4 bivalents in the hybrid. The amphidiploid of *N. paniculata* × *N. glutinosa* (2n = 48) has not been mentioned so far in the literature (Fig. 5). In the meiosis of the

hybrid studied for several generations (F_1, F_2, F_3) bivalent formation was observed in general (24_{II}) with a very low quadrivalent frequency ($1-3_{IV}$). It is worth mentioning that in general, seed setting of amphidiploid hybrids in the first generation is poor due to the low pollen fertility; pollen fertility of amphidiploids produced by us — on the other hand — was nearly 80 per cent, thus a normal seed set was obtained. Germinating ability of seeds had been low but improved in later generations.

4. Diploid and amphidiploid interspecific hybrids of *N. glutinosa* (n = 12) × *N. glauca* (n = 12). The first relevant data were found in KOSTOFF's papers (1930, 1943). In the meiosis of the hybrid he described 10—12, 8—10 (1930) and 3—7 bivalents (1943) respectively. Our investigations confirm the latter

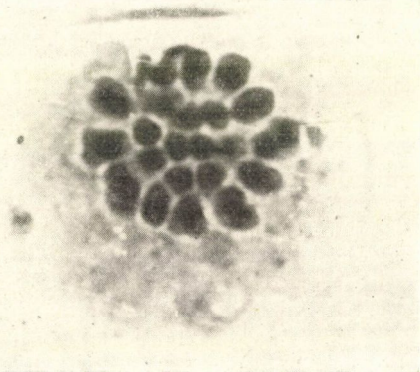

Fig. 6. Meiosis of *N. glutinosa* × *N. glauca* amphidiploid with 24 bivalents (×600)

data, in the meiosis of our hybrids generally 3—7 bivalents were found. It is supposed that chromosomes belonging to the same genomes associate (autosyndesis), which confirms GOODSPEED's suggestion (1954), namely, that the basic chromosome number of the *Nicotiana* genus was originally 6. The first *N. glutinosa* × *N. glauca* amphidiploid (2n = 48) was produced by KEHR—SMITH (1952). Hybrids obtained by them were fertile in the F_1 generation, but the progenies were sterile. LATTERELL (1958) also mentioned this amphidiploid. According to his description F_1 plants showed somatic instability. We produced this hybrid in 1963; the plant is of stable phenotype even after the fourth generation. In the pollen mother cell generally 24 bivalents were found (Fig. 6). Deviation is caused probably by the different initial plant materials used.

5. Diploid and amphidiploid hybrids of *N. bigelovii* (n = 24) × *N. tabacum* (n = 24). CHRISTOFF (1928) found 0—10 while KOSTOFF (1943) 0—3 bivalents in this hybrid. We generally observed 5—9 bivalents. On the basis of haploids of *N. tabacum* containing 1—2 bivalents KOSTOFF suggests autosyn-

desis. The produced amphidiploid *N. bigelovii* × *N. tabacum* showed regular meiosis in F_1, F_2 and F_3 with 48 bivalents.

CLAYTON (1950) reported a diploid *N. debneyi* × *N. tabacum* interspecific hybrid. The hybrid obtained by him had split blossom.

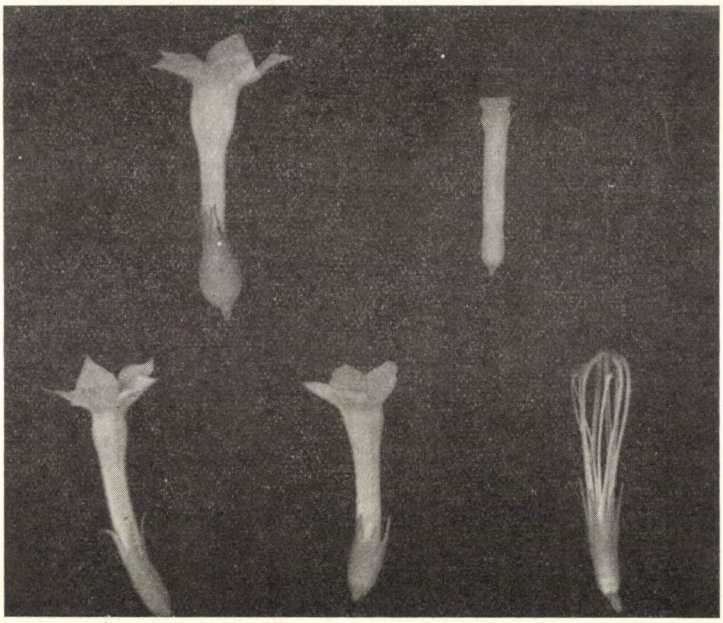

Fig. 7. Morphologically different flowers of the polygenomic hybrid of *N. bigelovii* × *N. tabacum* × *N. glauca*

6. The polygenomic hybrid of *N. bigelovii* (n = 24) × *N. tabacum* (n = 48) × *N. glauca* (n = 12) which is not presented in Table 2 had the same split blossom. Among the hybrid plants interesting morphological variations have been found (Fig. 7). They can be divided into three groups:

a) flowers with yellow colour,

b) flowers with pink colour (tabacum type),

c) plants with split blossoms.

In the polygenomic hybrids appearance of distorted forms is caused by a disturbance in the interaction of genomes. In chromosome division a high degree of abnormality and very frequent dyad formations (75 per cent), were observed. Crossing was repeated in 1966, and we succeeded in raising two plants. Both of them were of different type. Deformation of stamens prevented us from studying the meiosis. Results obtained from investigations of mitosis suggest that the great morphological differences may be traced back to abnormal chromosome division followed by the instability of chromosome

number. (The chromosome number in the somatic cells was 48, 32, 35, 40, 44 and 60.) We carried out several crossings between the obtained hybrid plants and various tetraploid species *(N. knightiana, N. glutinosa, N. paniculata);* in the fully developed fruits only primordial seeds were found. The absence of seed formation was probably caused by the degeneration of the endosperm.

Acknowledgement

I am deeply indebted to Director Barna GYŐRFFY for his useful advices during the experiments, and also to László Csősz, for assistance.

REFERENCES

APPA RAO—KRISHNA MURTY K. V. (1963): Studies on multiple polyploids in *Nicotiana*. Genetica, **34**, 66—78.

CLAYTON, E. E. (1950): Male sterile tobacco. Jour. Hered., **41**, 171—175.

GOODSPEED, T. H. (1954): The Genus *Nicotiana*. In: Waltham: Chronica Botanica Co.

GYŐRFFY, B. (1944—45): Colchicinezési eljárások (Colchicin treatments). Agricultura, Magyaróvár, 35—39.

GYŐRFFY, B. (1963): Dohány és paradicsom hybridek citogenetikai vizsgálata (Cytogenetic studies of tobacco and tomato hybrids). MTA Biol. Oszt. Közl., **14**, 243—268.

KEHR, A. E.—SMITH, H. H. (1952): Multiple genome relationships in *Nicotiana*. Agr. Expt. Sta. Ithaca. Mem., **311**, 3—9.

KOSTOFF, D. (1943): Cytogenetics of the genus *Nicotiana*. State Print House, Sofia.

KRISHNA MURTY, K. V.—BHAT, N. R. (1958): Cytogenetics of the amphidiploid *N. glutinosa* × *N. trigonophilla*. Indian J. Genet., **18**, 224—232.

LATTERELL, R. L. (1958): Morphogenetic investigations on somatic instability in the F_1 hybrid of *N. glutinosa* by *N. glauca*. Dissertation Abstracts, **19**, 1177.

SMITH, H. H. (1968): Recent cytogenetic studies in the Genus *Nicotiana*. Advances in Genetics, **14**, 1—3.

TAKENAKA, Y. (1962): Cytogenetic Studies in *Nicotiana* XV. Japan J. Breeding, **1**, 80—86.

TAKENAKA, Y. (1963): Reduction divisions in three interspecific hybrids and one amphidiploid. Japan J. Genet., **2**, 135—141.

TERNOVSKY, M. F. (1962): Polyploidy in the *Nicotiana* genus. Plant polyploidy. Transactions of the conference on plant polyploidy. Moscow, 230—238.

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STUDIES ON THE RHIZOSPHERE MICROFLORA OF RICE

By

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The rhizosphere microflora of rice plant has been studied in the present investigation under different stages of growth. Total microflora, actinomycetes, Azotobacter, nitrifiers and cellulose decomposers have generally shown a positive rhizosphere effect. This is because of root secretion, plant debris, and the relatively higher oxygen tension around roots than the soil apart. On the other hand, Closridia, sulphate reducers and denitrifiers have given a negative rhizosphere effect. This is simply due to anaerobiosis which disturbs the microbial equilibrium being in favour of the growth of these organisms.

Introduction

It is fully established that the roots of plants support a microbial flora which differ qualitatively and quantitatively from those of the soil apart from roots. This has stimulated great interest among soil microbiologists, plant pathologists and physiologists. Katznelson—Lochhead—Timonin (1948) made a full review on the rhizosphere subject; since then, accumulated literature has revealed the importance of the rhizosphere. Timonin—Thexon (1950), Fedorov—Nepomiluev (1954), Riviera (1964) and many others contributed to this. Several investigators have reported that the rhizosphere microflora differs markedly from the soil flora. The rhizosphere of many plants has been reported to support greater population of bacteria which are more capable of growing rapidly and physiologically more active types than non-rhizosphere organisms (Rovira 1956, Katznelson—Rouatt 1957, and Mahmoud—Aboul-Fadl—Elmofty 1964).

In view of the fact that intensive studies have been focused to non-aquatic economical plants and no attention has been paid to aquatic plants, it may be of interest to study the rhizosphere microflora of rice. This plant is considered to be the second economical crop after cotton in U.A.R. It spends most of its life period under aquatic conditions. Such is expected to disturb the microbial equilibrium which may affect the succeeding crop since rice is the only aquatic plant incorporated in the rotation system North of the Nile Delta.

The study entails the rhizosphere microflora with special reference to some active groups of microorganisms which carry out some important processes namely non-symbiotic nitrogen fixation, nitrification, cellulose decomposition, nitrate and sulphate reduction in soils.

Materials and Methods

The soil used in this investigation was fertile clay loam (organic matter 1.88 per cent and total nitrogen 0.98 per cent). It was obtained from the Agricultural Experimental Station at Giza, sieved and mixed thoroughly and placed in 2 adjacent cemented lysimeters 2×10 m; one cultivated with rice; the other was not but received the same treatments (soil apart). This was carried out to eliminate the rhizosphere effect in samples of soil apart due to the aquatic condition and plant density.

Rice seeds (Nahda variety) were planted in the usual manner. The seeds were left for 15 days to germinate in the soil containing about 60 per cent of water holding capacity, then the soil was flooded with water till maturity. Later, the soil was drained off; a usual practice carried out before cropping.

It should be mentioned that no fertilizers were added to the soil, to eliminate their effects on the microbial population.

Rhizosphere samples were collected by mulshing the plant and cutting the root system with a pair of scissors sterilized with 70 per cent of alcohol. The samples were transferred to the laboratory in sterilized wide mouthed bottles.

Samples from the soil apart were collected separately by using a semi-micro auger.

Microbiological methods. The method of TIMONIN (1940) has been adopted. Cultural methods were used for counting the microbial population in the rhizosphere and soil apart by the plate count and dilution frequency methods.

Each sample was analyzed in duplicate, and the counts were calculated to obtain the number of microorganisms per one gram dry weight of the soil.

Total microflora were grown on soil extract yeast agar medium SKINNER—JONES—MOLLISON (1955) modified by MAHMOUD (1955) as follows: K_2HPO_4 0.5 g, yeast extract 0.5 g, glucose 0.1 g, soil extract 500 ml, tap water 500 ml, agar 15 g, and pH 7.2. For aerobic spore formers, the respective dilutions were pasteurized at 80°C for 15 minutes before inoculating the medium.

Actinomycetes count was determined on Jensen's medium, after ALLEN (1961).

Azotobacter was determined on Base medium 77; while nitrogen fixing Clostridia was counted on modified Winogradsky's medium (ALLEN 1961).

Stephenson's medium was used for counting nitrifiers; and glucose nitrate medium (ALLEN 1961) was used for denitrifiers.

Sulphate reducers were grown on Starkey's medium modified by ABD-EL-MALEK RIZK (1958).

For aerobic cellulose decomposers, Dubos medium (ALLEN 1961) was used.

Chemical methods. Total nitrogen was determined by the modified Kjeldahl method; and organic matter was determined by the Walkely and Black wet digestion method (JACKSON 1958).

For moisture determinations, samples were dried at 105°C overnight to constant weight.

Results

The average counts of microflora determined by the plate method and dilution frequency method per g dry wt. of soil of the rhizosphere and soil apart have been recorded in Table 1, illustrated by Fig. 1.

Total microbial flora. Total microbial flora of soil apart was nearly similar to that of rhizosphere during the seedling stage, being in the order of

31 millions. As plant gets older, the rhizosphere soil showed significantly higher counts than the soil apart, being 39.0, 33.6 and 53.0 millions in the tillering, heading and maturing stages, respectively. In the soil apart, however, counts were found to be 25.7, 15.0 and 21.7 millions in the aforementioned stages. Hence, it could be stated that there was a positive rhizosphere effect. R/S

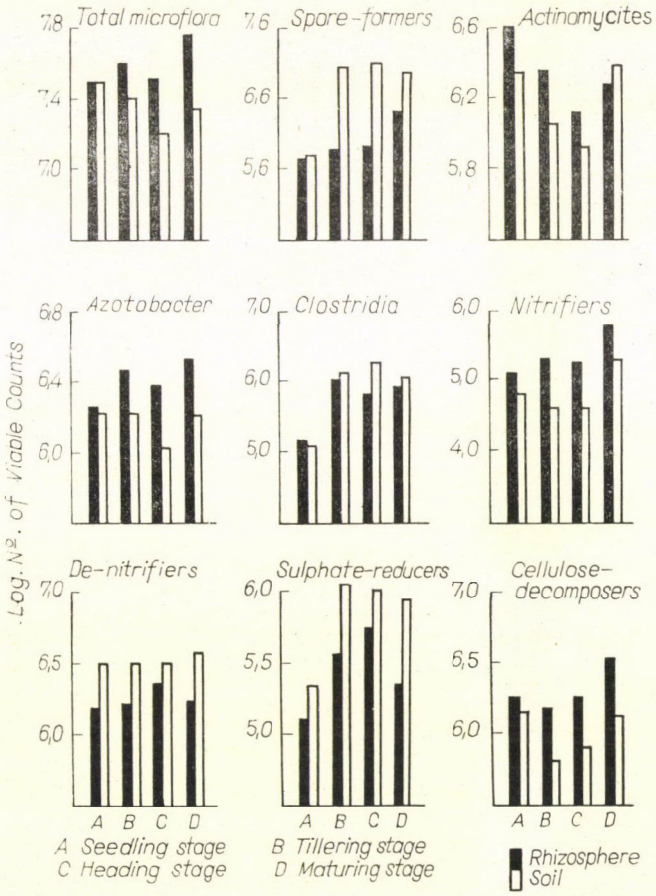

Fig. 1. Counts of microorganisms in the soil and rhizosphere of rice plant

ratios were 1.51, 2.24 and 2.44 in the same respective stages. The reason for such stimulating effect could be due to root secretions and plant debris which stimulated soil microorganisms around the roots. This is in agreement with other investigators such as ROVIRA (1956 a) and MAHMOUD—ABOUL-FADL—ELMOFTY (1964).

It should be pointed out in this respect that the rhizosphere effect was lower than at some non-aquatic plants determined by several investigators (NAIM—MAHMOUD—HUSSEIN 1957, KADRY—MAHMOUD—ALAMA 1961). This

Table 1

The average counts of total microflora and specific groups in the soil and rhizosphere of rice Plant counts in millions/g dry weight of soil

	Seedling stage 30 days		Tillering stage 60 days		Heading stage 100 days		Maturing stage 120 days	
	R	S	R	S	R	S	R	S
Total microflora	31.552	30.950	39.077	25.792	33.690	15.083	53.095	21.742
Spore-formers	0.579	0.614	0.748	11.066	0.770	11.963	2.714	9.090
Actinomycetes	4.310	2.223	2.360	1.150	1.333	0.830	2.060	2.524
Azotobacter	1.725	1.664	2.840	1.670	2.366	1.049	3.275	1.505
Clostridia	0.135	0.124	1.040	1.188	0.614	1.727	0.788	1.158
Nitrifiers	0.135	0.057	0.187	0.043	0.176	0.041	0.667	0.197
Denitrifiers	1.508	3.199	1.600	3.100	2.240	3.188	1.697	3.820
Sulphate reducers	0.122	0.217	0.360	1.188	0.556	1.049	0.244	0.915
Cellulose decomposers	1.725	1.408	1.466	0.632	1.760	0.717	3.222	1.274

could be due to the aquatic conditions which diluted root secretions and lowered the decomposition rate of soil organic matter (TAHA—MAHMOUD—IBRAHIM 1966).

The gradual decrease recorded in the total microbial count as the experiment proceeded, could be attributed to the inhibition of the aerobic bacteria which constitute a large percentage of soil microflora. The anaerobic conditions maintained in the soil as a result of water-logging disturbed the microbial equilibrium being in favour of anaerobic and facultative aerobic microorganisms. These confirm the results obtained by TAHA—MAHMOUD—IBRAHIM (1966) who found that water-logging of paddy soil decrease the counts of total microflora.

A marked increase in the total microbial count was, however, recorded at maturing stage. This could be attributed to drying usually practiced in this period. Similarly, the rhizosphere effect was more pronounced. This is due to aeration which favour the growth and proliferation of most of soil microorganisms on plant debris.

Spore-formers. Spores were found to be present in lower count in the rhizosphere than in soil apart giving negative rhizosphere effect. R/S ratios were found to be 0.94, 0.06, 0.06 and 0.30 in the seedling, tillering, heading and maturing stages, respectively. This indicates that such organisms are sooner present in the active vegetative phase in the rhizosphere than in soil apart. This is possibly due to nutrients supplied by the roots, excessive moisture and the relatively high oxygen tension due to gas exchange as a result of root respiration.

The high counts recorded in soil apart samples in the tillering and heading stages could be due to the low oxygen tension existing in the soil as a result of flooding. This gets the active vegetative form to the resting spore phase. The reduction in the spore count recorded in soil apart as a result of soil drying could be attributed to the germination of more spores due to favorable conditions which prevailed later.

Spore-formers were found by several investigators to be present in high densities in Egyptian soils (MAHMOUD 1955, MOBAREK 1960, ABDEL-HAFEZ 1962 and TAHA *et al.* 1965). They suggested that these organisms played an important role in organic matter decomposition. This contradicts other investigators who found spore-formers to be present in low counts in temperate regions and postulated that these zymogenic organisms were only active when organic matter were present in ample quantities beyond farm application (WINOGRADSKY 1924, CONN 1948). The presence of these organisms in the active vegetative phase in the rhizosphere is — in the present investigation — an additional proof to their importance in the soil.

Actinomycetes. Actinomycetes were found to play an important role in soils of warm climatic conditions (JENSEN 1943). They were found to be present in high densities in fertile and deteriorated Egyptian soils (ABDEL-HAFEZ 1962, EL-SAID 1963, TAHA—MAHMOUD—IBRAHIM 1964, 1965).

In general, the rhizosphere soil showed higher counts of actinomycetes than soil apart, giving positive rhizosphere effect. R/S ratios were found to be 2, 2, 1.5 in the seedling, tillering and heading stages, respectively. The gradual decrease recorded in their counts in both rhizosphere and soil apart could be attributed to the aquatic conditions which had a deleterious effect on the growth and proliferation of such organisms (TAHA—MAHMOUD—IBRAHIM 1966).

A marked increase was, however, recorded in the counts of actinomycetes in both soil apart and rhizosphere soil at maturing stage. This count was much higher in the soil giving a negative rhizosphere effect (R/S ratio = 0.80). This is probably due to the presence of more moistened condition around the roots in this stage than in soil apart.

Non-symbiotic nitrogen fixing organisms. Non-symbiotic nitrogen fixing organisms namely *Azotobacter* and *Clostridia* have also been studied in the present investigation. This is of great interest since the former is aerobe and the latter is anaerobe.

In general, *Azotobacter* and *Clostridia* were found to be present in high densities in both soil and rhizosphere of rice. This, however, confirms earlier investigators who found *Azotobacter* to be present in high densities in Egyptian soils (ABDEL-HAFEZ 1962, IBRAHIM 1964). They stress their importance in nitrogen fixation in such soils as their densities could be taken as an index of the amount of fixed nitrogen in soils (JENSEN 1940).

Azotobacter was present in higher counts in the rhizosphere than in soil apart. The highest count was recorded in the tillering stage (2.8 millions). However, the drying of oil greatly increases *Azotobacter* count in the rhizosphere (3.2 millions). Such increase could be attributed to the high oxygen tension and the presence of available sources of energy during such a period.

A positive rhizosphere effect was generally observed during sampling periods denoting that roots furnish favourable environment for the growth of *Azotobacter*.

Unlike *Azotobacter*, *Clostridia* showed higher counts in soil apart than in the rhizosphere giving negative R/S ratios. The highest count of *Clostridia* was recorded in the heading stage. This, however, coincided with the lowest count of *Azotobacter* in the soil. This could be attributed to the prevalence of anaerobic conditions which favour the growth of *Clostridia* and hinder that of *Azotobacter*.

In general, *Azotobacter* was present in higher counts in the rhizosphere than *Clostridia*, whereas *Clostridia* showed higher counts in the soil than in the rhizosphere. This, however, confirms results obtained by TAHA—MAHMOUD—IBRAHIM (1966). They found that flooding condition of paddy soils greatly increased the counts of *Clostridia* and decreased that of *Azotobacter*. In this respect, it may be stated also that *Azotobacter* may be benifited by the growth of Algae which is normally present in paddy soils in Egypt. Such organisms supply *Azotobacter* with a stream of oxygen during photosynthesis.

Nitrifiers and denitrifiers. Nitrification is one of the most important soil processes which depends mainly upon ammonification carried out by soil microorganisms. The density of nitrifiers was generally low as compared with results obtained in non-aquatic plants and unflooded soils. This could be attributed to the presence of low oxygen tension in this soil as a result of flooding.

However, nitrifiers were found to be present in higher densities in the rhizosphere than in soil apart showing a positive rhizosphere effect. This could be due to the relatively high ammonification process existing around roots and the relatively higher oxygen tension due to more gas exchange as a result of root respiration and algae growth unlike the stagnant condition in soil apart.

On the other hand, denitrifiers were present in high densities in both rhizosphere and soil apart. Their counts were, however, higher in soil apart than in the rhizosphere, giving negative R/S ratios. In fact, the counts of such group of microorganisms were found to be still high in spite of soil drying at maturity stage. This points out to their deleterious effect when the soil is manured with nitrates during the second crop. This, however, confirms the results obtained by TAHA—MAHMOUD—IBRAHIM (1966) who recommended the application of ammoniacal fertilizers for the next crop after rice to evade the

deleterious effect of denitrifiers. VERHOEVEN (1952) also stated that nitrate reduction could take place in poorly aerated and well aerated soils.

Sulphate reducers. Similarly to denitrifiers, sulphate reducers were found to be present in higher densities in soil apart than in the rhizosphere, showing a negative rhizosphere effect. The highest counts were, however, obtained at the tillering and heading stages, followed by a marked decrease during drying at the maturing stage.

Cellulose decomposers. The rhizosphere soil showed generally higher counts of aerobic cellulose decomposers than soil apart giving a positive rhizosphere effect, due to the presence of relatively high oxygen tension, and plant debris. R/S ratios were found to be 1.2, 2.3, 2.4, and 2.5 in the seedling, tillering, heading and maturing stages, respectively.

Discussion

Rice is considered to be the second crop after cotton in U.A.R. It is the only aquatic plant incorporated in the rotation North of the Nile Delta. In this respect, it was found interesting to study the rhizosphere microflora of such plant. This is of great importance, since water-logging is expected to disturb the microbial equilibrium in the soil and rhizosphere.

Total microflora, *Actinomycetes*, *Azotobacter*, nitrifiers and cellulose decomposers have generally shown a positive rhizosphere effect. This is because of root secretion, plant debris, and of the relatively higher oxygen tension around roots than in the soil apart.

Counts of these organisms were generally lower than that obtained with other economical plants in U.A.R. such as beans, tomatoes and cotton (NAIM—MAHMOUD—HUSSEIN 1957, KADRY—MAHMOUD—SALAMA 1961). This may be attributed to the dilution of nutrients, low oxygen tension and the low rate of organic matter degradation under such anaerobic conditions (TAHA—MAHMOUD—IBRAHIM 1966).

On the other hand, *Clostridia*, sulphate reducers and denitrifiers gave a negative rhizosphere effect. Such organisms have been found to be present in higher densities in the soil than in the rhizosphere. This is simply due to anaerobiosis which disturbs the microbial equilibrium being in favour of the growth of these organisms. It is of great interest to note that after the drying denitrifiers and sulphate reducers were still present in high densities in the soil. This is of great agronomic importance as nitrate and sulphate amendment of the second crop is not advisable. Such anions will be reduced by these organisms. Therefore, ammoniacal nitrogen and elementary sulphur should be applied for the succeeding crop, to evade the deleterious effects of nitrate and sulphate reducers.

REFERENCES

ABDEL-HAFEZ, A. M. (1962): Seasonal variation of soil microflora and its effect on soil nitrogen. M. Sc. Thesis, Fac. of Agric., Ain Shams Univ., U.A.R.

ABD-EL-MALEK, Y.—RIZK, S. G. (1958): Counting of sulphate reducing bacteria in mixed bacterial populations. Nature, **182,** 538.

ALLEN, O. N. (1961): Experiments in soil bacteriology, Burgess Publishing Co., Minneapolis.

CONN, H. J. (1948): The most abundant groups of bacteria in soil. Bact. Rev., **12,** 257—273.

EL-SAID, F. A. (1963): Effect of reclamation of alkali soil on microflora. M. Sc. Thesis, Fac. of Agric. Ain Shams Univ., U.A.R.

FEDOROV, M. V.—NEPOMILUEV, V. F. (1954): The fundamental forms of the rhizosphere bacteria of clover and their quantitative content in the rhizosphere according to the phase development and the age of the plant. Mikrobiologiya **23,** 431—437.

IBRAHIM, A. N. (1964): Microorganisms and their activities in relation to soil fertility. Ph. D. Thesis, Fac. of Agric. Ain Shams Univ., U.A.R.

JACKSON, M. L. (1958): Soil chemical analysis. Constable and Co. London.

JENSEN, H. L. (1940): Contributions to the nitrogen economy of Australian wheat soils. Proc. Linnean Sci. N.S. Wales **65,** 1—122.

JENSEN, H. L. (1943): Proc. Linnean Sci. N. S. Wales, **68,** cf. Russell, Soil Conditions and Plant Growth, 1961.

KADRY, A.—MAHMOUD, S. A. Z.—SALAM, S. (1961): Factors influencing the germination of *Orobanche* seeds. Annals of Agric. Sci., Ain Shams Univ., **6,** 147—168.

KATZNELSON, H.—LOCHHEAD, A. G.—TIMONIN, M. I. (1948): Soil microorganisms and the rhizosphere. Bot. Rev., **14,** 543.

KATZNELSON, H.—ROUATT, J. W. (1957): Studies on the incidence of certain physiological groups of bacteria in the rhizosphere. Can. J. Microbiol., **3,** 265—269.

MAHMOUD, S. A. Z. (1955): Sporeformers occurring in soils. Their germination and biochemical activities. Ph. D. Thesis, Leeds Univ., England.

MAHMOUD, S. A. Z.—ABOUL-FADL, M.—ELMOFTY, M. KH. (1964): Studies on the rhizosphere microflora of a desert plant. Folia Microbiologica **9,** 1—8.

MOBAREK, M. S. (1960): Addition of organic manures to Tahreer soil and their effect on microflora and some plant nutrients. M. Sc. Thesis, Fac. of Agric. Ain Shams Univ., U.A.R.

NAIM, S. M.—MAHMOUD, S. A. Z.—HUSSEIN, A. M. (1957): Qualitative and quantitative studies on the rhizosphere microflora of some Egyptian cotton varieties. Ain Shams Sci. Bull., **2,** 65—84.

RIVIERA, J. (1964): Effect of rhizosphere microorganisms on the growth of wheat. II. Isolation and characteristics of bacteria producing plant hormones. Ann. Inst. Pasteur, **105,** 303—314.

ROVIRA, A. O. (1956): Plant root excretions in relation to the rhizosphere effect. II. Study of the properties of root excreta and their effect on the growth of microorganisms isolated from the rhizosphere and control soil. Plant and Soil, **7,** 178—194.

ROVIRA, A. O. (1956): Plant root excretions in relation to the rhizosphere effect. III. The effect of root exudates on number and activity of microorganisms in soil. Plant and Soil, **7,** 209—212.

TAHA, S. M.—MAHMOUD, S. A. Z.—EL-DAMATY, A.—IBRAHIM, A. N. (1965): Effect of prolonged use of fertilizers on some chemical and microbiological properties of soil. The 1st Conf. of Microbiology, U.A.R.

TAHA, S. M.—MAHMOUD, S. A. Z.—IBRAHIM, A. N. (1964): Effect of reclamation of alkali soils on some chemical and microbiological properties in U.A.R. The 8th Conf. of Soil Sci., Romania.

TAHA, S. M.—MAHMOUD, S. A. Z.—IBRAHIM, A. N. (1965): Effect of reclamation of saline soils on some chemical and microbiological properties in U.A.R. The 1st Conf. of Microbiology, U.A.R.

TAHA, S. M.—MAHMOUD, S. A. Z.—IBRAHIM, A. N. (1966): Microbiological and chemical properties of paddy soil. Plant and Soil, XXV, 222—232.

TIMONIN, M. I. (1940): The interaction of higher plants and soil microorganisms. 1. Microbial population of rhizosphere of seedlings of certain cultivated plants. Can. J. Res., **18,** 307.

TIMONIN, M. I.—THEXTON, R. H. (1950): The rhizosphere effect of onion and garlic on soil microflora. Soil Sci. Soc. Amer. Proc., **15,** 186—189.

VERHOEVEN, W. (1952): Aerobic sporeforming nitrate reducing bacteria. Uitgeverij Waltman Delf.

WINOGRADSKY, S. (1924): Microbiologie du sol. Sur l'étude de l'anaerobiose dans la terre arable. Natel, Compt. Rend. Acad. Sci., **179,** 861.

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INCREASE OF THE FREE PROLINE LEVEL IN WATER DEFICIENT LEAVES AS A REACTION TO SALINE OR COLD ROOT MEDIA

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Leaves of plants grown under optimum conditions contain a very low proportion of proline among their free amino acids. In most cases it can be demonstrated by paper and layer chromatography only when developing by isatine is applied. However, after 2—3 days of water deficiency in the plants the proline content of the leaves becomes many times as much as the normal.

Large-scale accumulation of proline points, like an indicator, to water deficiency in the leaves even if plenty of water is involved in the root medium, though its uptake is somehow inhibited. By increasing the salt content of irrigation water we induced physiological drought. In spite of the high total salt content, resp. osmotic pressure of soil solution, the water uptake by root system requires more energy as indicated after 2—3 days by a considerable increase in the proline concentration of leaves.

If the difference between the temperatures of the root medium and the dry air flow surrounding the shoots is great, the water loss by transpiration cannot be supplemented, owing to the reduced activity of the root system, and water deficiency turns up in the leaves. This water deficiency is well indicated by the great increase in the proline content of leaves. In our experiment low temperature in the root medium was produced by cooling.

Introduction

Examining free amino acid of *Cynodon dactylon* grown in culture pots, it was found that as a reaction to water deficiency the proline content of plants became 10—100 times as high as in the irrigated controls (BARNETT—NAYLOR 1966). During the water loss of detached wilting leaves proline was also found to have increased to a great extent (THOMPSON *et al.* 1966). When studying plants grown in culture pots and in the field (wheat, rice, tobacco, paprika, sunflower, bean, pea) we, too, found that proline concentration of leaves increased rapidly with growing water deficiency in plants (PÁLFI 1968a, 1968b). On detached leaves wilting in both light and dark, and by saccharose infiltration of isolated leaves we pointed out that in water deficient leaves proline was not of direct protein origin but derived from carbon hydrates through oxidative phosphorylation (PÁLFI—JUHÁSZ 1968). The process of proline formation was namely inhibited by 2,4-DNP. In the course of our investigations we have come to the definite conclusion that proline content rising many times above the normal level indicates in every case water deficiency and this phenomenon may occur in any phase of the development of plants.

Sometimes the root system may not be able to supply the shoots with water, although sufficient quantities of water are available for the plant in the soil. This phenomenon is called — as it is well-known — physiological drought and occurs when total salt content of the soil is high. Physiological drought may also occur when temperature in the root medium is too low as compared with that of the air surrounding the shoots.

In our present experiment we wished to reveal whether soil solutions of high salt concentration or a root medium with low temperature do cause water deficiency in spite of adequate quantities of water available. If the proline content in the leaves of plants grown under the above conditions considerably increases as compared with the control, water deficiency is certainly present, as indicated by our data obtained so far.

Material and Method

Plants were grown in culture pots containing a mixture of sand and soil (2 : 1) under optimum conditions in sunshine and irrigated from time to time with Knop's culture fluid. We began irrigating the soil of 50 days old paprika plants (Capsicum annuum L.) every second day alternately further with tap water, and every second day with Van't Hoff's salt solution composed of 0.1 n NaCl (1000 parts), $MgCl_2$ (78 parts), $MgSO_4$ (38 parts), KCl (22 parts), and $CaCl_2$ (20 parts). The total salt content of this solution was increased to 2 per cent (pH 6) by adding Na_2SO_4. Controls continued to be irrigated with tap water every day, so both groups were given the same daily amount of water. After having made the medium saliferous for a fortnight, we took leaf samples for analysis. In the media of 30 days old sunflowers (Kisvárdai), 24 days old peas (Express) and 21 days old beans (Black prinz) salt content of the soil was increased in the same way. Three culture pots per treatment were set in the experiment.

The full water capacity of shoots was determined by cutting off shoots grown under optimum conditions and placing them for twice four hours each into glass containers filled with tap water. Meanwhile they were ventilated, i.e. exposed to air for one hour. During the whole time the plants were illuminated, and finally weighed.

For cooling the root media, sunflower, bean and paprika plants were grown until the age of 30, 21 and 50 days respectively, also in culture pots containing sandy soil, but this time with artificial illumination (4000 lux for 12 hours a day). Then the plants were removed one by one from the pots with soil and transplanted into glass containers of 12 cm height and 7 cm in diameter. In the subsequent two days the injured plants were discarded. During that time the root medium adopted the temperature of air (24°C). Then the containers of one of the variants were placed into a cooling fluid, cooled in 8 hours gradually to 8°C and kept for 3 days at this temperature, while the root medium of the control remained at 24°C. After 3 days the leaves of the plants were fixed. During the experiment soils of the cooled and control groups were kept at the same moisture level (70 per cent water content as calculated in the full water capacity of soil).

Ethanol extracts were developed on one- and two-dimensional uptake papers (butanol-acetic acid-water; 2 : 1 : 1, and phenol-methanol-water; 3 : 1 : 1). The method was described in detail by SZALAI (1957) and HARTMANN (1965). With proline the blue colour of the isatine reaction was measured with spectrophotometer. At the total amino acid determinations, the complex red colour of the copper-salt obtained after the ninhydrine reaction was measured with the comparative standard-mixture method (PÁLFI 1965a).

Results

The variants irrigated with Van't Hoff's solution of increased total salt content and balanced ion antagonism fell strongly back in development as compared with controls irrigated with tap water. There was a great difference also in the size and thickness of leaves and thickness of stalks in favour of the controls. Data obtained during the analysis are presented in Table 1.

Table 1

Fresh and dry matter as well as water content of shoots of plants irrigated with tap water and with water of 2 per cent total salt content; proline and total amino-acid concentration of leaves

Mean value and average error

Plants	Soil quality	Fresh weight of 10 shoots	Dry matter of 10 shoots	Water content %*	Proline mg/g dry matter	Total amino acid** mg/g dry matter
Capsicum annuum L.	normal	11.21	1.45	70.6	0.36 ±0.016	9.64 ±0.42
	saline	7.06	1.14	58.3	21.74 ±0.92	12.10 ±0.58
Helianthus annuus L.	normal	15.00	1.55	80.0	0.42 ±0.02	6.52 ±0.28
	saline	8.18	1.12	61.4	22.28 ±1.06	12.34 ±0.56
Pisum sativum L.	normal	9.34	1.03	82.2	0.58 ±0.026	11.06 ±0.46
	saline	4.94	0.76	62.8	3.64 ±0.14	14.54 ±0.62
Phaseolus vulgaris L.	normal	12.26	1.42	71.5	0.34 0.018	12.24 ±0.60
	saline	6.58	1.08	57.7	1.46 ±0.068	18.82 ±0.72

* Water content in percentage of full water capacity
** Without proline and asparagine

Table 1 shows that the fresh green material of plants irrigated with tap water alone was considerably larger than that of the plants irrigated with water of 2 per cent total salt content. The dry-matter content of the 10 shoots was also higher in plants irrigated with tap water. It is obvious that in paprika and sunflower the proline content increased 60 and 53 times above that of the control, respectively. Proline content shows essential differences — though

to a lower extent — also in peas and beans, being 6.3 and 4.3 times higher in plants irrigated with water of increased salt content than in controls.

Table 1 shows further that, besides the proline content, the total amount of free amino acids also increased by 30—90 per cent in plants grown in highly saline soil, compared with the control. It is also remarkable that in paprika and sunflower plants grown in highly saline medium the amount of proline is nearly twice as much as the total amino acid content. In peas and beans it is the other way round, namely, the total amino acid contents are higher than the proline contents. It should be mentioned furthermore, that in plants grown in highly saline media the amount of asparagine, not shown in the table, also increased to 5—6 times more than that of the control.

It was found that plants irrigated with water of 2 per cent total salt content — though the water amount was the same as that for the control — had a permanent water deficiency as proved by the extremely high concentration of proline. This result is confirmed by the data on water content for the plants (Table 1). We cut off 10 paprika and 10 sunflower shoots above the soil surface and attached rubber pipes to the stumps in order to obtain some root pressure sap. In controls 11.5 ml and 23.8 ml resp. guttation sap was obtained in 12 hours, while the stumps in saline media did not produce any sap at all. This fact also shows that water supply in plants grown in a saline medium is considerably reduced.

It is known that in normally saline, natural soils, too, Na salts are dominant, just like in Van't Hoff's irrigation solution used by us. In plants grown in such soils high quantities of Na-ions may accumulate, in competition with other nutritive ions during the uptake (PÁLFI 1965b). When measuring the Na content in the leaves of the four plants included in Table 1 by means of a flame photometer, we found that in plants kept for a fortnight in a medium of increased salt content, Na concentration became 15—20 times as high as that in the control, which is also a damaging factor.

In Table 2 fresh and dry weights are not presented, since in the course of weighings no significant differences in dry matter content were found between the individual groups. The water content of plants kept in a root medium of 24°C was 10—16 per cent higher than of those kept at 10°C. This difference is, however, not sufficient to support our observation, that plants kept in a colder medium seemed withered. However, proline content which grew 2—3 times as much as in the control proves undoubtedly that in a medium of cold temperature roots cannot supply the shoots with sufficient water. The total amino acid content is also higher in plants kept in a cold medium, which suggests a stagnation of protein synthesis, too, in that case.

Fig. 1 shows the amino acid composition of sunflower plants, with their controls, as developed under the influence of three kinds of treatment. With phenolic solvents applied, proline has the highest Rf value, it is therefore

Table 2

Water content of shoots of plants kept at the same air temperature (24°C), in soils of different temperatures (24°C and 8°C); proline and total amino-acid concentration of leaves

Plants	Soil temperature	Water content %*	Proline	Total amino acid**
			mg/g dry matter	
Helianthus annuus L.	24°C	76.4	0.53	7.36
			±0.02	±0.32
	8°C	68.2	1.78	11.04
			±0.08	±0.50
Phaseolus vulgaris L.	24°C	70.8	0.46	9.66
			±0.02	±0.46
	8°C	62.6	0.88	14.80
			±0.04	±0.62
Capsicum annuum L.	24°C	71.5	0.51	8.08
			±0.024	±0.38
	8°C	58.7	1.92	10.22
			±0.086	±0.48

* Water content in percentage of full water capacity
** Without proline and asparagine

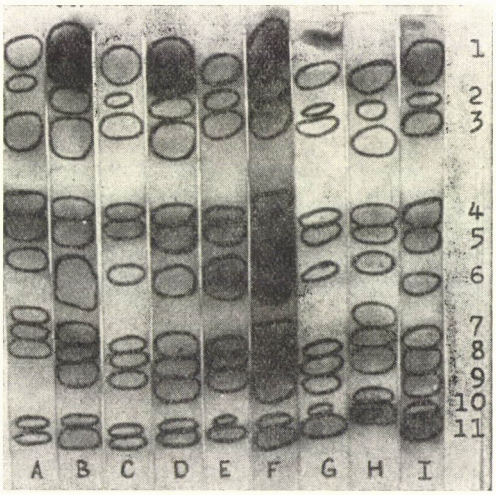

Fig. 1. Free amino acids in leaves of sunflower plants kept in non-irrigated cultured soil, in soil irrigated with water of 2 per cent total salt content, and in irrigated but cooled soil, respectively. A = irrigated with tap water; B = non-irrigated; C = irrigated with tap water; D = irrigated with water of 2 per cent total salt content; E = in soil of 24°C; F = in soil of 8°C temperature; G, H, I = mixture of known, weighed quantities of amino acids, with a total amino-acid content of 25, 50 and 75 microgram. 1 = Pro; 2 = Phe; 3 = Leu; 4 = Val+Met; 5 = γ-Amb; 6 = Glu$-NH_2$+Ala+Arg; 7 = Thr+Lys; 8 = Asp$-NH_2$+Gly; 9 = Glu+Ser; 10 = Cys (II); 11 = Asp.

evident, that proline content of the non-irrigated control as well as of plants grown in saline and cold media has increased many times above the level of controls. Fig. 1 shows further that in cases of higher proline concentrations also the total amino-acid contents are higher than in the control.

In summer in this country there may often occur high differences in temperature of the root medium of soil and the atmosphere surrounding the shoots. During cloudy and rainy periods of 7—10 days the soil cools down

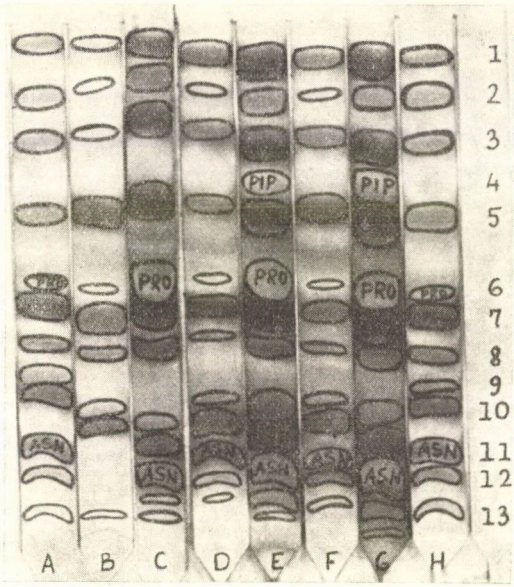

Fig. 2. Free amino acids of plants kept for 3 days in soils of 24 and 8°C temperatures, respectively, but at the same air temperature (24°C). A, H = mixture of known weighed quantities of amino acids with a total amino-acid content of 50 and 75 microgram; B = paprika in a soil of 24°C; C = paprika in a soil of 8°C; D = sunflower in a soil of 24°C; E = sunflower in a soil of 8°C; F = beans in a soil of 24°C; G = beans in a soil of 8°C. 1 = Leu; 2 = Phe; 3 = Val+Met; 4 = Pipecholic acid; 5 = γ-Amb; 6 = Pro; 7 = Ala; 8 = Glu+Thr; 9 = Gly+Ser; 10 = Asp+Glu$-NH_2$; 11 = Asp$-NH_2$+Arg; 12 = Lys; 13 = Cys (II)

gradually. Then the cool period is suddenly replaced by hot, sunny days, the wind also changes direction and an arid, warm air flow follows. It is then, that the so-called "top-drying" occurs with rice. The inundated soil is still cold, the roots are of reduced activity and cannot regain the transpirational water losses increased by the hot wind. Tips of the upper leaves wither and become white. Damage is even greater when rice was sown into a saline soil, because water uptake is made harder by the high salt content and osmotic pressure of soil solution. This physiologically weakened state is indicated also by high quantities of proline and pipecolic acid appearing among the free amino acids of the leaves (PÁLFI 1967, 1968c). In the course of our present

experiment pipecolic acid mostly occurred in considerable quantities in water deficient plants. Fig. 2 shows that in leaf extracts of sunflowers, peas and beans kept in cooled root media also some blue patches of pipecolic acid can be demonstrated by ninhydrine development, besides a high amount of proline. Pipecolic acid remains blue even after copper or nickel salt fixation, while most amino acids turn scarlet. It should be mentioned that even with butanol-acidum aceticum solvent applied, pipecolic acid can be separated from the subjacent γ-aminobutyric acid only when developed in a medium below 0°C (for 36 hours).

It is known that non-protein-bound hydroxyproline inhibits elongation and growth alike. The question arises whether or not a part of the very high amount of proline produced by water deficiency is hydroxyproline. In order to answer this question, we added hydroxyproline in adequate quantity to our usual comparative solution containing the amino acids known and applied so far, and developed it on the same paper as the water deficient leaf extracts of high proline content (pea, bean, tobacco and paprika plants). After several similar paper developments we found that hydroxyproline — like proline — though giving yellow patches with ninhydrine and blue ones with isatine, has much lower — by 35 mm — Rf value than proline. Accordingly, in the leaves of the plants examined no hydroxyproline was produced as a reaction to water deficiency.

Discussion

In the course of our experiments we found that in case of water deficiency in intact plants and isolated leaves the total free amino-acid and amide contents of leaves considerably increased. This increase in the free amino acids — as it was pointed out by PETINOV—BERKO (1965), GENKEL *et al.* (1967) as well as by us (PÁLFI 1968a) — is a result of stagnant protein synthesis. However, among the free amino acids in the leaves of water deficient plants proline was found to increase to the highest extent (PÁLFI 1968b, VLASYUK *et al.* 1968, PROTSENKO *et al.* 1968). The proline content of leaves suffering from drought may reach a level higher than the total amount of other amino acids + amides. The proline content of water deficient leaves may be even a hundred times as high as the proline concentration of the control leaves optimally supplied with water (PÁLFI 1968b, PÁLFI—JUHÁSZ 1968).

By salifying gradually the soil of plants grown in the first half of the vegetative period in culture pots under relatively optimum conditions, we tried to find out whether high proline concentration occurs in the leaves indicating water deficiency when water content is sufficient and there is a high osmotic pressure in the root medium. Data obtained during the examinations performed with paprika, sunflower, pea and bean plants uniformly show that plants may suffer from water deficiency even in the case of a great total

salt content of an optimum amount of water available in the soil. Taking into consideration that solutions of balanced ion antagonism were used to increase the salt content of the soil, and that the pH value of the solution was not over 6, we can state that water deficiency resulting from the high osmotic pressure of the root medium in acid, saline soils can be a considerable damaging factor. Water deficiency of plants kept in soil solutions of high salt content is indicated — besides the extremely high proline concentration of shoots — by water content values and guttation data, too. Further, it was pointed out that in leaves of plants kept in saline medium the amount of Na is 15—20 times more than the normal, which is also a damaging factor (PÁLFI 1956b). When examining plants grown in saline seaside soils GOAS (1966) also found that, in case of identical water supply, proline concentration was higher in plants grown in soils of higher salt content. It is by all means an important finding that even a minor but permanent (2—3 days) water deficiency causes a 200—300 per cent proline increase in leaves (PÁLFI 1968b). This phenomenon can be utilized in practice when determining the actual time of periodical irrigation in large-plot farming. Namely, the relative quantity of proline can be determined in 1—2 hours by thin layer chromatography with phenol-alcohol-water solvent applied, because proline has the highest Rf value.

Our data suggest the conclusion that among the cultivated varieties of a plant species it is the more drought-resistant that synthetizes as a result of an identical water deficiency, larger quantities of free proline. As supposed by others (PROTSENKO *et al.* 1968, VLASYUK *et al.* 1968) proline may have the role of increasing the hydratation of protoplasma in case of water deficiency. After further investigations, this information can be used by plant breeders for selecting more drought-resistant varieties.

Water deficiency may also occur if the root system of plants lives in a soil of low temperature while the shoots live in an arid air current of considerably higher temperature. In cold soils the ability of roots for water uptake and transport decreases, therefore the roots are not able to regain properly the water losses of the intensely transpiring shoots. In our experiment we attempted to clarify whether or not a physiological drought of that kind is also indicated by a great increase in the proline content. Data obtained on sunflower, bean and paprika plants show that the leaves respond to water deficiency resulting from low root medium temperature also with a significantly increased free proline concentration. Thus, it can be established that a manifold increase of proline content in leaves of plants supplied optimally with water points undoubtedly to water deficiency. This water deficiency may occur, however, not only in the case of reduced water content in the root medium, but also when soil solutions are available for plants in adequate quantities but their uptake requires more energy owing to a higher osmotic pressure, or a very low temperature (physiological drought).

The amino acid sets of proteins in the leaves of plants well supplied with water and of those wilting for 5 days have already been compared. Data obtained suggest that in the case of water deficiency the high protein content does not directly derive from protein decomposition (PÁLFI 1968a), namely, leaves wilting in the dark synthetize proline only till their carbon hydrate reserves are exhausted (3—5 days). After the sugars are exhausted, the large amount of proline produced so far also gets decomposed before the leaves become entirely dry (PÁLFI 1968b). Through saccharose infiltration of leaves wilting in the dark we pointed out that the large quantities of proline in water-deficient plants derive from sugars (PÁLFI—JUHÁSZ 1968). When the leaves of plants with optimum water supply were sprayed with 2.4-DNP prior to being deprived of water, no proline was produced; namely 2.4-DNP separates oxidative sugar decomposition and oxidative phosphorylation. This result, too, confirms the sugar origin of proline in case of water deficiency.

A disturbance of protein synthesis in leaves is often accompanied by the appearance of pipecolic acid, a nonprotein component amino acid (PÁLFI 1968c). In our present experiment pipecolic acid was more than once demonstrated among the free amino acids of leaves of water deficient plants, also pointing to a disturbance of protein synthesis in water deficient leaves. A decrease in protein synthesis as compared to protein decomposition in water-deficient plants was directly proved as well (PÁLFI 1968b, PÁLFI—JUHÁSZ 1968).

REFERENCES

BARNETT, N. M.—NAYLOR, A. W. (1966): Amino acid and protein metabolism in Bermuda grass during water stress. Plant Physiol., **41,** 1222—1230.

GENKEL, P. A.—SATAROVA, N. A.—TVORUS, E. K.—Генкель, П. А. — Шатарова, Н. А. — Творус, Е. К. (1967): Влияние засухи на синтез белка и состояние рибосом в растениях. Физиол. Раст., **14,** 898—907.

GOAS, MARIE, L. (1966): Contribution à l'étude du métabolisme azoté des halophytes. Acides aminés et amides libres d'Aster tripolium L.C.R., Acad. Sci., D **263,** 260—263.

HARTMANN, T. (1965): Über das zeitliche Auftreten flüchtiger Amine und freier Aminosäuren in wachsenden saprophytischen Kulturen von *Claviceps purpurea.* Planta (Berlin) **66,** 27—43.

PÁLFI, G. (1965a): Relations between abundant N-supply and the amino acid concentration of various leaf levels of rice plants. Plant and Soil, **23,** 275—284.

PÁLFI, G. (1965b): The effect of sodium salts on the nitrogen, phosphorus, potassium, sodium and amino acid content of rice shoots. Plant and Soil, **22,** 127—135.

PÁLFI, G. (1967): Aminosäuren-Assimilation einiger Bakterien und ihre Verwendung zum Nachweis einer unbekannten Verbindung. Naturwissenschaften, **51,** 489.

PÁLFI, G. (1968a): Changes in the amino acid content of detached wilting leaves of *Solanum laciniatum* Ait. in the light and in the dark. Acta Agronomica Acad. Sci. Hung., **17,** 381—388.

PÁLFI, G. (1968b): Die Wirkung von Kinetin, 2,4-DNP und Antimetaboliten auf die Veränderungen im Aminosäurengehalt welkender Pflanzenblätter. Planta (Berl.), **78,** 196—199.

PÁLFI, G. (1968c): Relationship between the pipecolic acid content of the leaves and physiological condition of the rice plant. Il Riso, **17,** 13—22.

PÁLFI, G.—JUHÁSZ, J. (1968): The change of the amino acid reserves of plants due to the effect of water deficiency and saline soil. (Hung. Res. Engl.). Agrokémia és Talajtan, **17**, 243—254.

PETINOV, N. S.—BERKO, N. F.—Петинов, Н. С. — Берко, Н. Ф. (1965): Содержание свободных аминокислот в связи с ростовыми процессами кукурузы в условиях различного водоснабжения. Физиол. Раст., **12**, 56—63.

PROTSENKO, D. F.—SMATKO, I. G.—RUBANYUK, E. A.—Проценко, Д. Ф.—Сматько, И. Г.—Рубанюк, Е. А. (1968): Устойчивость озимых пшениц к засухе в связи с их аминокислотным составом. Физиол. Раст., **15**, 680—687.

SZALAI, I. (1957): Fotometrische Bestimmung des Gesamtaminosäurespiegels im Kartoffelsaft mittels der Ninhydrinreaktion. Acta Biologica, Univ. Szeged, **3**, 33—40.

THOMPSON, J. F.—STEWARD, C. R.—MORRIS, C. J. (1966): Changes in amino acid content of excised leaves during incubation. I. The effect of water content of leaves and atmospheric oxygen level. Plant Physiol., **41**, 1578—1584.

VLASYUK, P. A.—SMATKO, I. G.—RUBANYUK, E. A.— Власюк, П. А. — Сматько, И. Г. — Рубанюк, Е. А. (1968): Значение микроэлементов цинка и бора в аминокислотном обмене и засухоустойчивости озимой пшеницы. Физиол. Раст., **15**, 281—287.

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STUDIES ON THE RESIDUAL EFFECTS OF INSECTICIDES APPLIED INTO THE SOIL

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The chlororganic insecticides: DDT, HCH, lindan, heptachlor, dieldrin and aldrin, applied to wheat, beans, sugar beet and oats/vetch mixture by soil treatment exercise specific influence on the plants' growth and yields according to the rates of application.

The tested chlororganic insecticides are absorbed by plants and are accumulated in the grain yields, the residues vary from 0.1 to 1.2 ppm.

Introduction

The chlororganic insecticides are considered the basic chemicals for the control of some harmful soil insects *Scarabaeidae*, *Elateridae*, etc. (Stefanov—Zashev 1952, Nikoloca—Mincova—Radev 1957, Popov 1961, Popov 1959, Brammanis 1956, Regnier 1954, Richter 1957). High rates were often recommended for higher efficiency, with hexachlorane, for instance, reaching 24—27 kg active substance per ha. Chlororganic preparations are widely applied for the control of insects from the species *Coleoptera*, *Lepidoptera*, *Diptera*, etc. (Popov 1956, Kovatchevsky 1967). For the control of *Bothynoderes punctiventris* Germ. most of all HCH was used. Repeated treatment of the seedlings at short intervals and treatment accompanied by digging was recommended (Bogdanov 1963) for the purpose of burying the preparation in the soil. After 1963 heptachlor, aldrin, dieldrin and lindan were introduced in the Bulgarian agriculture (Popov 1963, Popov 1969, Kovatchevsky 1967). Dieldrin became the most important insecticide for the control of *Bothynoderes punctiventris* Germ.

The chlororganic preparations, DDT, HCH, lindan, aldrin, dieldrin and heptachlor, which are insecticides of world-wide use, induced phenomena dangerous for human health and beneficial for animals. There arose the problem of their toxicity to the treated plants (Boswel 1952, Maier Bode 1965). Cases of harmful effect on the plant's growth were observed in Bulgaria. In 1962—1963 we observed squeezing of the roots on the soil surface and growth inhibition (Popov 1968).

Some authors discussed also the problem of the influence of the dif-

ferent application rates of these preparations on the yield of various crops (LAKOCY 1959, MANOLACHE—RADULESCU—MANOLACHE 1964).

There are some information on the influence of these preparations on plants. Those data, however, are few and insufficient. NIKOLOV—STAMBOLIEV (1963) observed 2.2—21 per cent squeezing of root tubercles of young sugar beet plants, after 7—10 successive uniform dustings with 20 per cent HCH (at two-day intervals). The preparation was not introduced in the soil, however. The field experiments of NIKOLOVA—MINKOVA—RADEV (1957) upon the influence of HCH introduced in the soil on the yields of maize, sunflower, sugar beet and tobacco showed that 12 per cent HCH at the rates of 50—120 kg per ha caused no harmful effect on the crops. High rates, however, (80—120 kg per ha) suppress the growth of tobacco seedlings.

Intense application of chlororganic insecticides results in their gradual accumulation in the soil. HARRIS—HITCHON—MANSON (1966) found residues of chlororganic insecticides in soils. The highest concentrations were established in open soils, planted with vegetable, tobacco crops and fruit trees. The residues from cyclodiene insecticides were considered very important because of the high persistency of their active substances (HARRIS—HITCHON 1966). The chlororganic insecticides are classified as insecticides with nonsystemic action. Studies show, however, that they must be regarded as nonsystemic only conditionally (LICHTENSTEIN 1965), since they are absorbed by plants even in very small amounts.

The first studies, carried out by MUNS—STONE—FOLEY (1961) show that the "nonsystemic" insecticide DDT is taken up by plants containing lypophilic substances, oils, waxes, etherial oils, mustard oil, etc., and also that crops, such as carrots, colza, raddish, cauliflower and lettuce take up from the soil appreciable amounts of chlororganic insecticides (HEINISCH—BEITZ—HARTISCH 1968). The specific properties of the insecticide, its concentration in the soil, the soil type and the climate are of great importance to the adsorption process. It has also been established that adsorption depends on the additives, which the preparation contains, emulsifiers, wetting agents, etc. (LICHTENSTEIN—FUHREMANN—SCOPES—SKRENTNY 1967).

These observations reasoned the necessity of studying some problems, and especially the problem of the influence of chlororganic insecticides, applied at high rates, on plant growth in the fields. All the more so as one of the authors (POPOV 1959, 1961), for the first time in Bulgaria, introduced high rates of HCH for killing the larvae of some *Melolonthinae* beetles. He also tested and recommended treatment with a preparation on heptachlor basis (POPOV 1963a, 1963b). At the same time a study was carried out to detect the insecticide residues and to find out whether these substances penetrate into the plants. Such residues can be determined by different methods, some of them based on infrared spectroscopy, gas chromatography, thin layer

chromatography, etc. (SCHÖNIGER 1958, 1959, BEYNON—ELGAR 1966, BLINN 1965, CZECH 1964, GAUL 1966, GOODWIN—GOUBLEN—REYNOLDS 1957, HAMMENCE—HALL—CAVERLY 1965, HEINISCH 1960a, 1960b, KATZ 1964).

Our studies represent the first attempt in Bulgaria to provide more systematic data on the growth of wheat, maize, beans, sugar beet and oats/vetch mixture in soils, to which different rates of DDT, HCH, heptachlor, lindan, dieldrin and aldrin have been applied. In the present article more complete data on the residues of these preparations in the yields — mainly in the seeds — are published. The data refer to the third vegetative period after the preparations were applied to the soil, — 1967.

Material and Methods

a) Methods of the agrobiological experiments. The experiment was launched in May 1965 in the experimental field of the Plant Protection Institute in Kostinbrod. The soil was leached chernozomic which is common in Bulgaria. This soil type provides a favourable environment for the growth and propagation of various soil insects, mainly *Rhizotrogus aequinoctialis* Hrbst., *Butosaria Bulgarica* Mink., *Agriotes ustularis* Schall., *Agrotis segetum* Schriff., etc. The treatment was carried out in May, 1965. The program of the experiment was as follows: a 0.5 ha area was divided into 6 equal parts of 700 m^2 each. Every plot was divided into 3 equal subplots of 233.3 m^2 designed for treatment with a normal rate (NR), for control (without treatment) (C) and for high rate treatment (HR) with the same preparation.

We chose for the experiments representative preparations from three widely used groups of chlororganic insecticides and the respective active substance rates as shown in Table 1.

Table 1

Preparations used in the tests

No.	Preparation	Normal rate (NR) kg/ha	High rate (HR) kg/ha
	I. On a DDT basis		
1.	DDT — 5%	7.50	15
	II. On a hexachlorocyclohexane basis		
2.	HCH — 20%	25	50
3.	lindan — 2.8%	2.80	5.60
	III. On a diene synthesis basis		
4.	heptachlor — 20%	15	30
5.	dieldrin — 75%	9.37	18.75
6.	aldrin — 5%	5	10

In practice only DDT, HCH and, to a certain extent, lindan are used at the mentioned rates. The other preparations are used at higher rates, corresponding to the amounts used for several treatments. Such cases are very frequent in practice.

The application of the preparations to the soil was carried out on October 20th, 1965. They were ploughed to an 8—10 cm depth. Aldrin was applied on October 6th, 1966.

The normal and high rate plots and the corresponding control plots were divided into 5 equal plots from 9 to 5 m each to ensure a fivefold crop rotation. The following crops were used in the rotation:

- wheat *(Triticum vulgare)*; the variety Bezostaya
- and in 1965 spring wheat; the variety Erythrospermum 142
- maize *(Zea mays)*
- beans *(Phaseolus vulgaris)*; the variety No 451
- sugar beet *(Beta vulgaris)*
- oats/vetch mixture

Soil and crop cultivation and harvesting were carried out ordinarily. Every year observations were carried out on the crop germination and growth. The possible appearance of pests and diseases was also recorded.

b) Methods of the chemical determinations. 100 g finely ground material was extracted with acetone in a Soxleth apparatus for 2 hours. The acetone extract was evaporated in a water bath to a constant weight. The chlorine content was determined by the oxygen-flask method. About 0.2 g of the extract was burnt. Hydrogen peroxide, diluted with water in the ratio of 1 : 5 was used as an absorption liquid. After removing the peroxide by boiling, the chlorine ions were determined nephelometrically by a Pulfrich type nephelometer.

It was taken into consideration that acetone itself extracts from the plants a greater amount of organic substances. On the other hand, it extracts more of the chlororganic insecticide itself. For the determination of the residues, however, there was no necessity of preliminary purification of the extract from substances which would interfere in the normal course of the analysis. The extracted substances burned completely and induced no negative effect on the analysis.

Results and Discussion

On the effect of the applied preparations the different crops behaved differently during the vegetative periods and gave different yields.

During the vegetative period, up to May 5, 1967, the wheat in the treated plots grew better than in the control plot, while with dieldrin the control crop was in better condition. Maize showed identical results and even more damages caused by mole-crickets *Gryllothalpa gryllothalpa* L. were observed in the control plot. Beans grew better in the controls immediately after germination and in the plots treated with lindan and aldrin in comparison to those treated with DDT, heptachlor and dieldrin; this correlates with the yields of the different crops. Sugar beet in the high-rate heptachlor plot showed a markedly weaker growth. Occasionally squeezing of the roots and root tubercles were observed in the HCH-treated plots. In the growth of the oats/vetch mixture no marked difference was observed.

The yields harvested in 1967 from the plots treated with preparations in the above-mentioned rates are shown in Table 2.

It was clear, in the third year, that high rates of application exerted no harmful effect on wheat. On the contrary, the yields were considerably higher, with the exception of the dieldrin-treated plot where the yield was approximately normal. Spring observation showed that the crop in the control plot was in better condition, but later all crops became equal. Maize also gave approximately normal yield. Growth inhibition was caused only by the high dieldrin rates. They exerted a harmful effect on beans even in the third year

Table 2

Percentage yields from the NR-treated and HR-treated plots, harvested in 1967, as compared to yields from the control plots

Crops	Preparation and rate	DDT		HCH		Li	
		NR	HR	NR	HR	NR	HR
Wheat		117.6	115.6	75.1	106.2	108.2	122.4
Maize		102.5	117.2	108.6	102.3	112.1	103.6
Beans		106.1	84.8	97.6	86.9	89.1	109.8
Sugar beet		120.1	104.0	100.1	95.2	133.3	127.6
Oats/vetch mixture		135.2	133.6	95.1	102.3	118.0	141.3

Crops	Preparation and rate	He		Di		Al	
		NR	HR	NR	HR	NR	HR
Wheat		107.7	103.1	98.5	99.2	124.0	111.8
Maize		98.1	112.1	111.5	91.8	114.3	116.8
Beans		90.2	70.6	91.2	100.0	103.3	109.8
Sugar beet		99.9	68.1	98.1	81.9	82.4	111.2
Oats/vetch mixture		94.8	102.7	101.2	120.8	93.8	103.8

following the application. DDT, HCH and heptachlor had a more pronounced harmful effect and the yield after a high-rate treatment was reduced by 13 per cent. HCH affected sugar beet adversely, but not very strongly, while heptachlor caused growth inhibition and yield decrease. The positive influence of lindan is obvious. The growth of oats/vetch mixture was normal, lindan and DDT gave positive results.

The preparations' influence on the yield of different crops is specific. As can be seen from Table 2 DDT causes no harmful effect, except for beans, when high rate (15 kg active substance per ha) is being applied. The yield was reduced by 15.2 per cent. HCH caused a 34.1 per cent yield decrease, only for beans. As the yield data show lindan, at the rates used, had a positive effect on the yield, especially in wheat, which gave a 15.6—17.6 per cent surplus; in sugar beet 27.6—33.3 per cent, and in oats/vetch mixture 18—14.1 per cent. Heptachlor at the high rate of 3 kg caused a markedly harmful effect on the yields of beans and sugar beet. Dieldrin (HR) also caused a harmful effect, mainly on the yield of maize (8.2 per cent) and sugar beet (18 per cent). It should finally be pointed out that although the crops were planted one year after aldrin had been applied to the soil, it had a positive effect on the yields of almost all. Probably this was due not only to its insecticidal activity, but also to the fact that it was applied to the soil at a twice smaller rate than dieldrin and did not cause growth inhibition. Since the yields correspond

to growth at the vegetative period, it follows that the effect of the preparation on the yield is a result of its influence during the vegetative period.

The data of chemical determinations are very important. The chemical analyses of the residues in the yields of the test crops indicate that chlororganic insecticides show a very high persistency in the soil, which results in their presence in the plants and a tendency to being absorbed by and accumulated in the crops. A fact, ignored by other authors, is that these substances are absorbed by and move in crop plants, such as wheat, sugar beet, etc., in which the lipoids are not a prevailing component.

The test results are given it Table 3. As can be seen from the table all the chlororganic insecticides were more or less absorbed by and accumulated in the plants.

Table 3

Residues of chlororganic insecticides in crop plants, ppm

Preparation	Rate	Crop plant				
		beans	maize	oats/vetch mixture	wheat	sugar beet
DDT	HR	0.3	0.5	0.3	0.3	0.7
	NR	0.2	0.3	0.2	0.2	0.5
	c	<0.1	<0.1	<0.1	<0.1	<0.1
HCH 12%	HR	0.7	1.2	0.2	0.3	0.7
	NR	0.4	0.5	0.2	0.2	0.3
	C	<0.1	<0.1	<0.1	<0.1	<0.1
Lindan	HR	0.7	1.2	0.4	0.4	0.7
	NR	0.4	0.6	0.2	0.2	0.3
	C	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	HR	—	1.1	—	—	0.6
	NR	—	0.7	—	—	0.3
	C	—	<0.1	—	—	<0.1
Dieldrin	HR	0.8	1.2	0.3	0.4	0.6
	NR	0.5	0.4	0.2	0.3	0.4
	C	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	HR	0.7	1.0	0.3	0.4	0.6
	NR	0.5	0.4	0.2	0.3	0.4
	C	<0.1	<0.1	<0.1	<0.1	<0.1

The water solubility of the chlororganic insecticides, which is on the order of 10^{-6}—10^{-3} g/ml should be taken into consideration. The active substances of the applied preparations are soluble in oils. It should also be considered that the water solutions of plant saps and lipophilic substances are a two-

phase liquid-liquid system, for which the law of distribution of the dissolved substances in the phases is valid. It means that the insecticide will be extracted from the liquid phase and the lipophilic phase will be enriched by it. It follows that the small amounts of chlororganic insecticides dissolved in water are moved by the sap in the whole plant and accumulate in the organs, containing lipophilic substances. The considerably low fat and wax contents in the oats/vetch mixture and in wheat confirm this assertion. The rate of residues in sugar beet is, however, very high, for which we cannot give an explanation. This problem is subject to further studies.

It is of interest to point out that insecticides from the diene group tend much more to accumulate than the chlororganic insecticides from the remaining two types of hexachlorocyclohexane compounds and DDT.

REFERENCES

Beynon, K. I.—Elgar, K. E. (1966): The analysis for residues of chlorinated insecticide and acaricides. Analyst, **91,** 143—175.

Blinn, R. C. (1965): Infrared techniques useful in residue chemistry. J. Assoc. Offic. Agric. Chemists, **48,** 1009—1017.

Bogdanov, V.—Богданов, В. (1963): Да проведем правилно борбата сресту цвекловите хоботнизы. Раст. Защ., **11,** 28—32.

Boswel, V. (1952): Residues, Soils and Plants on Insects. The Yearbook of Agriculture, Washington, 284—297.

Brammanis, L. (1956): Bidrag till kännedomen om för scogen scadlige bladhorningar i Sverige II Pingborren. Meddelongen fram statens skoksforskingsinstitut, **46,** 1—123.

Czech, F. P. (1964): Analysis of insecticides in aqueous emulsion used in livestock dips and sprays. J. Assoc. Offic. Agr. Chemists, **47,** 829—837.

Gaul, J. A. (1966): Quantitative calculation of gas chromatographic peaks in pesticide residues analysis. J. Assoc. Agric. Chemists, **49,** 389—399.

Goodwin, E. S.—Goublen, R.—Reynolds, H. (1957): Flavour of selected vegetables grown in pesticide-contaminated soils. J. Agr. Food Chem., **5,** 44—48.

Hammence, J. H.—Hall, P. S.—Caverly, D. J. (1965): The identification and determination of chlorinated pesticide residues. Analyst, **90,** 649—656.

Harris, C. R.—Sans, W. W. (1967): Absorption of organochlorine insecticide residues from agricultural soils by root crops. J. Agr. Food Chem., **15,** 861—863.

Heinisch, E. (1960a): Chemische Methoden zum Nachweis oder zur Bestimmung von Pflanzenschutzmittelrückständen auf oder in pflanzlichem Erntegut. II. DDT. Nachrichtenbl. Dtsch. Pflanzenschutzd., **14,** 1—4.

Heinisch, E. (1960b): Chemische Methoden zum Nachweis oder zur Bestimmung von Pflanzenschutzmittelrückständen auf oder in pflanzlichem Erntegut. III. Hexachlorocyclohexan. Nachrichtenbl. Dtsch. Pflanzenschutzd., **14,** 86—98.

Heinisch, E.—Beitz, H.—Hartisch, I. (1968): Über die Kontamination landwirtschaftlich und gärtnerisch intensiv genutzter Böden in der DDR mit DDT und Lindan. Nachrichtenbl. Dtsch. Pflanzenschutzd., **22,** 61—67.

Katz, D. (1964): The problem of revealing chlorinated insecticides on thin-layer chromatograms. J. Chromatography, **15,** 269—272.

Kovatchevsky, I.—Ковачевский, И. (1967): Справочник за защита на растениата от болезни и неприятелы. София, Земиздат.

Lakocy, A. (1959): Wplyw HCH i Chlordanu na plonovanie roslin uprawnych. Roczn. Nauk. Poln., **74,** 1047—1061.

LHOSTE, J.—D'AGNILAR, I.—GERARD, J. (1965): Considerations sur l'emploi de l'heptachlore utilisé en traitement du sol. Paris.

LICHTENSTEIN, E. P.—FUHREMANN, T. W.—SCOPES, N. E. A.—SKRENTNY, R. F. (1967): Translation of insecticides from soil into pea plants. J. Agr. Food Chem., **15,** 864—869.

LICHTENSTEIN, E. P. (1965): Research in Pesticides. N. Y. Academic Press, 199.

MAIER BODE, H. (1965): Pflanzenschutzmittelrückstände. Eugen Ulmer, Stuttgart.

MANOLACHE, C.—RADULESCU, E.—MANOLACHE, F. (1964): Beiträge zur Frage des Einflusses einiger Insektizide auf die Pflanzen und Bedeutung ihrer Rückstände. Nachrichtenbl. Dtsch. Pflanzenschutzd., **18,** 1—8.

MUNS, R. P.—STONE, M. W. —FOLEY, F. (1961): Residues in vegetable crops following soil application of insecticides. J. Econ. Entomol., **53,** 832—834.

NIKOLOV, E.—STAMBOLIEV, M.—Николов, Е. — Стамболиев, М. (1963): Употребата на hexachlorana и влияние тому за нормалного развитие и растеж на захарното цвекло. Раст. Защ., **11,** 6—10.

NIKOLOCA, V.—MINCOVA, C.—RADEV, R.—Николоца, В. — Минцова, С. — Радев, Р. (1957): Вркадните телени червей (Elateridae) в България. Изв. на зоол. инст., **6,** 233—273.

POLIZU, AL. (1966): Remanenta preparatelor organochlorurate pe produsele agricole in urma tratamentelor efectuate. Probleme agricole, **11,** 55—64.

POPOV, P. — Попов, П. (1959): Проучвания върху биологията на юнските брумбары *(Amphimallon)* в България и средства за борба. Научни трудове ИСР, **2,** 33—74.

POPOV, P.— Попов, П. (1961): Майските брумбары *(Melolontha)* в България. II. Средства за борба. Изв. на ИСР, **1,** 49—95.

POPOV, P.—Попов, П. (1963а): Възможности за приложение на препарата heptachlor за борба с неприятелите на културните растения. Селскостопанска наука, **2,** 216—222.

POPOV, P.—Попов, П. (1963б): Масовата поява на ипсилоновата ноштенка прес 1963 в България. Раст. Защ., **11,** 27—31.

POPOV, P.—Попов, П. (1968): Непубликованные данные.

POPOV, P.—Попов, П. (1969): Телените черве *(Elateridae, Coleoptera)* като неприятели на чаревицата в България. III. Борба Чрез предпосевно третиране на скмената с инсектициды. Растениевадни науки.

POPOV, V.—Попов, В. (1956): Земеделска ентомология. Земиздат, София.

REGNIER, R. (1954): La lutte contre les Hannetons et les vers blancs. Actualités agronomiques, Paris, Serie C **1.**

RICHTER, G. (1957): Die Maikäfer- und Engerlingsbekämpfung. Flublatt, **22,** BZA d DAL Berlin.

SCHÖNIGER, W. (1958): Analytical procedures for the flask combustion method. Proc. Internat. Symposium Microchem., Birmingham.

SCHÖNIGER, W. (1959): Una determinazione microanalitica rapida dell' alogeno in sostanze organiche. Labor Sci., **7,** 107—112.

STEFANOV, D.—ZASHEV, B.—Стефанов, Д. — Зашев, Б. (1952): Използване на hexachlorana и ДДТ за борба срещу ларвите на юнския и майския брумбар *(Amphimallon solstitialis* i *Melolontha melolontha)* в горските разсадницы. Научни трудове ССА, Лесотехн. фак., **1,** 83—96.

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INVESTIGATION ON THE ROOT DEVELOPMENT OF JONATHAN APPLE TREES GRAFTED ON M IV STOCK AND GROWING IN CLAY SOIL

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The paper deals with the root development of one- to six-year-old spindle-bushy Jonathan apple trees grafted on M IV stock and grown in clay soil according to the cultural practices used in the Hungarian large-scale orchards. From each age class 9 specimens were examined. The results revealed that the previous dressing method applied for more than 6 years had not followed suitably the annual development and areal expansion of the root system.

Introduction

Field examination of the root system of fruit trees requires very meticulous, strenuous and pertinacious work. Orchard dressing was built up on two basic theories by the experts of fruit growing. Prior to the thirties the so-called "drip" theory was set up by KERNER (1888), according to which the absorbing roots of fruit trees are located in the soil in compliance with the projection of the crown, the so-called drip. Contemporary fruit growers had elaborated the dressing system of fruit trees on the basis of this theory. Numerous investigation data on fruit trees of bearing age published by KVARAZKHELIA (1930) in the thirties, however, proved the indefensibility of the drip theory and called the attention to the superficial dressing of the whole area of orchards. These basic but essentially conflicting establishments led to the investigation on the root system of various fruit tree species — particularly of apple trees — of different ages, grafted on various stocks and growing under special conditions.

Material and Method

The examined 1- to 6-year-old spindle-bushy Jonathan apple trees were planted with 7×4 m spacing on clay soil in the dry-cultivated apple orchard of the Nagykanizsa State Farm belonging to the hilly geographical region of the county Zala. Among the meridional valleys characteristic of this region uniformly high, flat roofed ridges bordered with unequal slopes and built up of Pannonian sediments as well as of loessic materials from dropping dust are to be found. Under the influence of the woody vegetation settled on the loess base rock a brown forest soil of the "lessivé" type and containing a humus layer of medium thickness developed. The soil shows a neutral or slightly acid reaction; aeration, water and nutrient management, nitrogen and phosphorus supply are moderate, the humus content is low, the total salt content is physiologically not harmful.

Prior to the establishment the planting hole of each one-year-old tree was dressed with 25 kg turfaceous faecal manure, 250 g nitrogen, 200 g phosphorus, 250 g potassium; to the two-year-old trees 30 kg organic manure, 300 g N, 250 g P and 300 g K were added.

The three-year-old specimens obtained 40 kg organic manure, 500 g N, 400 g P and 500 g K, while the four-year-old ones 1 kg N, 800 g P and 600 g K each. At the age of five the doses were 1.5 kg N, 1 kg P and 1.5 kg K, while in the last year 2 kg N, 1.5 kg P and 2 kg K.

Till the age of three, P was thrown out in spring, K in spring and July, N similarly in two portions in spring and June under the branch systems, while from the age of four, in the area outside the branch system, under the green manure plants. Depending on the age of trees and on the extent of their branch syste dressing materials were worked in with a spade, disc or plough to 15—20 cm depth.

During the last 10 years the examined area and its environment have received 727 mm precipitation annually in the average and in favourable distribution, because more than 50 per cent of its total quantity (369 mm) has fallen in the vegetation period.

The position occupied in the soil by the root system of the examined 1- to 6-year old-trees grafted on M IV stock was fixed by the aid of the so-called "skeleton" method, i.e. the growing space of all examined 9 trees in each age class was divided by a wirework into quadrates of 1 square meter. Subsequently within a circle of 80 cm diameter surrounding the tree, the soil was carefully excavated disengaging thus the skeleton roots and their ramifications. Starting from the stem the skeleton roots next to the surface and all their ramifications were first released from the soil and simultaneously their pictures fixed according to a certain scale and the data registered. In contradiction to other field methods this procedure of examination permits to disclose the different moments of root growth as a function of the species and variety of the fruit tree, of its stock, age, of soil conditions and agricultural practices. By this method also the soil properties may be recognized, that damage the development of the root system and inhibit probably the establishment of a new orchard (hard pan, unfavourable ground water level), etc.

Results and Discussion

One- to six-year-old Jonathan apple trees grafted on M IV stock were used as experimental material. Their roots younger than one year have a yellow colour, the older ones are brownish-yellow.

In the period of root development both the younger and older roots are covered with rootlets from their starting point to the tip. Beginning already with the first year, around the stems a wreath-like root system composed of longer or shorter thin absorbing roots develops. This establishment is in full accordance with the findings of PROBOCSKAI (1959) and ROEMER—HILKENBÄUMER (1937).

In the course of subsequent investigations in each class and as the average of 9 trees, the per-tree quantity of roots 0.1 cm, or more in diameter was determined, in order to find out the proportions of the different thick roots at the given age, using identical stocks on the same soil type (Table 1).

The data of Table 1 demonstrate that the quantity of 0.1 to 0.5 cm thick roots of three-year-old trees grafted on M IV stock was more than double in relation to those of one-year-old specimens, indicating the increased horizontal and vertical expansion of the root system as well as the multiplying of its nutrient absorbing surface. At the age of six, the amount of 0.1 to 0.5 cm thick roots is nearly fivefold of the quantity found in one-year-old trees.

The yearly comparison of the quantities of 0.1 to 0.5 cm thick roots and their multiplying with advancing age coincide in reality with the conspicuous energetic development of young trees following their initial weaker growth after plantation. The roots 0.1 to 0.5 cm in diameter are very valuable, because they produce the greatest amount of rootlets bearing root hairs (Fig. 1).

Table 1

Average quantity of roots 0.1 cm and more in diameter of 1- to 6-year-old Jonathan apple trees grafted on M IV stock and growing in clay soil

Diameter of roots cm	Quantity of different thick roots in the average of one Jonathan apple tree (age)					
	1	2	3	4	5	6
0.1—0.5	89.00	191.55	189.30	258.33	362.30	428.30
0.6—1.0	7.88	27.00	38.60	26.44	59.30	51.80
1.1—1.5	0.55	7.44	9.00	4.33	9.50	17.00
1.6—2.0	—	2.66	5.30	2.55	8.60	8.80
2.1—2.5	—	1.44	1.60	0.22	3.80	1.50
2.6—3.0	—	0.44	1.10	0.44	2.90	2.60
3.1—3.5	—	0.22	0.80	—	1.60	1.50
3.6—4.0	—	—	0.20	0.22	1.30	2.00
4.1—4.5	—	—	—	—	0.40	0.30
4.6—5.0	—	—	0.60	—	0.20	0.30
5.1—5.5	—	—	—	—	—	0.80
5.6—6.0	—	—	—	—	0.40	0.40
6.1—6.5	—	—	—	—	0.10	—
6.6—7.0	—	—	—	—	—	—
7.1—7.5	—	—	—	—	—	0.20
7.6—8.0	—	—	—	—	0.40	—
8.1—8.5	—	—	—	—	0.20	0.20
Total:	97.43	230.75	246.50	292.53	451.00	515.70

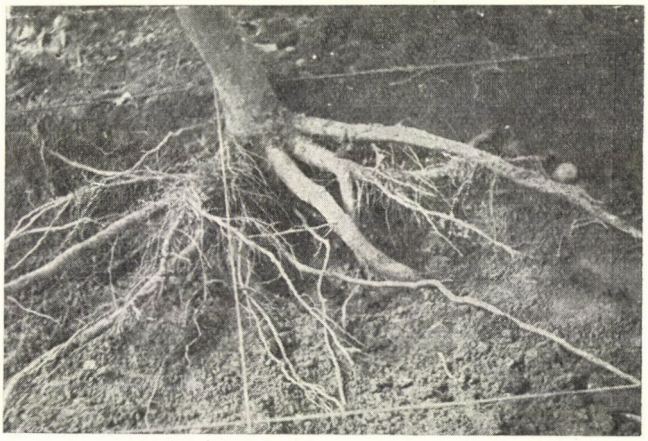

Fig. 1. Partly excavated root system of three-year-old spindle-bushy Jonathan apple tree grafted on M IV stock and growing in clay soil. The so-called "root-wreath" consisting of thinner roots and surrounding the stem is clearly visible

With advancing age a gradually ascending tendency can be observed in the total number of 0.6 to 8.5 cm thick roots: the five- and six-year-old trees have the thickest roots. The root investigations of SUTA—MODORAN—DUMITRACHE (1957) revealed that the proportion of thin roots is considerably (by 15 to 20 per cent) lower on sites rich in nutrients than in poor soils.

The depth position and thickness of roots thinner than 0.1 cm is very difficult to measure, therefore only their length was established. The amounts of roots thus obtained are dealt with under the term "total length of roots thinner than 0.1 cm". From roots below 0.1 cm in diameter the Jonathan apple trees grafted on M IV stock standing in clay soil produced at the age of one year generally a total length of 35 m, in the next year 95.1 m, at the age of three, four, five and six 83.8, 97.5, 155.1 and 230.6 m, respectively. These roots are of great importance, because most of nutrients supplying active roots develop on them.

According to KOLESNIKOV (1958) the root system of fruit trees consists of 50—90 per cent active roots.

Comparative examination of the root and branch systems of Jonathan apple trees grafted on M IV stock

As it was previously mentioned the shadowing organic manure and fertilizers were till the age of three, dispersed below the branch systems, while from the age of four they were applied to the stripes between the branch systems and worked in to 18—20 cm depth. The investigations proved that this areal method of fertilizing can be right only, if the expansion and location of root systems in the space and soil are well-known.

The methodical comparative examination of the supra- and subterranean parts revealed that — in contradistinction to the data gained on sand soils and disregarding some few roots reaching greater distances — on clay sites of better water and nutrient management, the expansion degrees of root and branch systems in 1- to 6-year-old Jonathan apple trees grafted on M IV stock are identical. Accordingly on clay soil and in case of normal development the surface to be fertilized can exactly be determined on the strength of the annually increasing areal expansion of the branch system (Fig. 2).

KEMMER (1947) and HILKENBÄUMER (1959), investigating the root development of young, 1- to 6-year-old apple trees grafted on M IV stock and growing on heavy soil, obtained similar results.

Weight proportions of the subterranean and aerial parts of Jonathan apple trees grafted on M IV stock

From the examined 1- to 6-year-old Jonathan apple trees in each age class and on a specimen of average development the total and relative weights of the root, stem and branch system have been established. The average

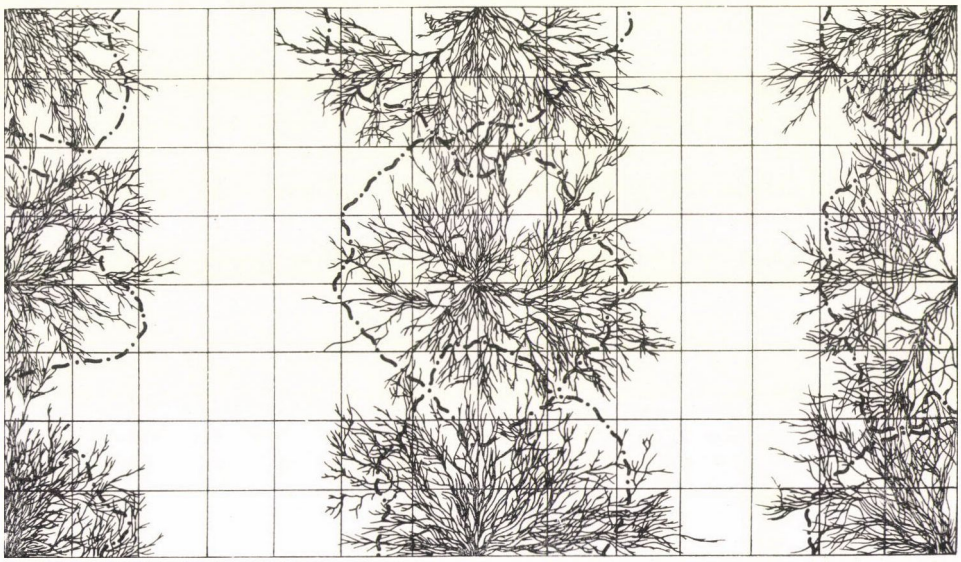

Fig. 2. Top-view of the root system of five-year-old spindle-bushy Jonathan apple trees grafted on M IV stock and planted in clay soil with 7×4 m spacing. The side of the squares is 1 m long. The projection of the crown (drip) is marked by a dotted line. Nearly the whole root system is located under the branch system

Table 2

Fresh weight of the subterranean and aerial parts of 1- to 6-year-old Jonathan apple trees grafted on M IV stock and growing in clay soil

Age of examined trees	Total weight of supra- and subterranean parts	Weight of			Weight proportion of the supra- and subterranean parts
		roots	stem	branch system	
years	kg				
1	0.91	0.28	0.30	0.33	1 : 2.2
2	3.70	1.20	1.10	1.40	1 : 2.0
3	12.80	4.80	1.90	5.50	1 : 1.5
4	20.83	8.13	2.80	9.60	1 : 1.5
5	33.60	9.80	4.90	18.90	1 : 2.4
6	35.30	12.70	3.90	18.70	1 : 1.7

development has been determined on the basis of the average stem diameters measured at three heights on 20 trees (Table 2).

From the data of Table 2 it turns out that the total fresh weight of one-year-old Jonathan apple tree grafted on M IV stock was exceeded by that of two-, three-, four-, five- and six-year-old trees by 4.1, 14.4, 22.8, 36.9 and 38.6 times, respectively. The weight of the root system of two-, three-, four-,

five- and six-year-old trees surpassed that of the one-year-old specimen 4.2, 17.1, 29, 35 and 45.3 times. In the above sequence the weight of the stem was 3.6, 6.3, 9.3, 16.3 and 13 times, that of the branch system 4.2, 16.6, 29, 57.2 and 53.6 times greater than in the one-year-old tree. In very young trees the weight proportion of the sub- and supraterranean parts depends chiefly on the nutrient richness of the site. The soil of the examined trees was poor in nutrients, however, in the first 2 to 3 years the weight proportion was shifted considerably in favour of the aerial parts. Still, this was not caused by the successively increasing nutrient richness of the soil, but by root losses due to cutting-back before plantation, as a consequence of which the weight proportion was considerably shifted in favour of the aerial parts (stem, branch system) and at the expense of the root system.

Areal extension and distribution of the root system of Jonathan apple trees grafted on M IV stock

The root system of the examined 1- to 6-year-old Jonathan apple trees grafted on M IV stock covers different large areas. The length of roots 0.1 cm and more in diameter, the extent of the area covered by them as well as the total length of roots per square meter inside and outside the drip were established as the average data of 9 trees in each age class (Table 3).

Table 3

Areal distribution of the root system of 1- to 6-year-old Jonathan apple trees grafted on M IV stock and growing in clay soil

Age of trees	Length of roots thicker than 0.1 cm	Average extent of the area			Average length of roots thicker than 0.1 cm	
		covered by the root system	under the drip	covered by the root system outside the drip	inside the drip	outside the drip
years	m	m^2			m	
1	44.91	3.23	1.37	1.86	33.56	11.35
2	123.42	5.70	3.26	2.44	104.14	19.27
3	160.30	10.56	5.11	5.45	133.49	26.91
4	185.34	15.50	7.89	7.64	143.08	42.25
5	294.39	18.20	11.28	6.95	245.65	39.74
6	291.36	20.29	10.29	10.41	236.82	54.54

The results thus obtained and presented in Table 3 show that the average length per tree of roots 0.1 cm and more in diameter increases gradually from year to year. The length and quantity of one-year-old roots are surpassed by more than the double in the second and by the treble value in the third year.

The root quantity of the four-year-old trees is 1.2 times, that of the five- and six-year-old specimens 1.8 times greater than in the three-year-old trees.

At the age of one, the root system of Jonathan apple trees grafted on M IV stock covered an area of 3.2 m^2, while in the 2nd, 3rd, 4th, 5th and 6th year 5.7, 10.5, 15.5, 18.2 and 20.2 m^2 respectively. Accordingly — knowing the horizontal extension of the root system of one-year-old spindle-bushy Jonathan apple trees grafted on M IV stock and growing in clay soil — the area to be dressed should be established as a 2 m broad stripe by measuring 1 m each outward from the stems right and left in the direction of the spacings. Similarly for the two-year-old trees in both directions 1.25 to 1.40 m (altogether 4.00 to 4.20 m), while for the three- and four-year-old trees 2.00 to 2.10 m (altogether 4.00 to 4.20 m), for the five-year-old trees 4.60 to 5.00 m and for those aged six 5.50 to 6.00 m broad stripes should be dressed.

At the given spacing (distance of tree rows) of 7 m neither of the roots of six-year-old trees come into contact, but in the rows, the trees were planted 4 m apart from one another and therefore, their roots meet already at the age of 3 to 4. Similar results were also obtained by GHENA (1961), who, in his root investigations found out that for apple trees the whole soil surface should be dressed only from the age of 8 to 9, as the roots of trees do not come into contact earlier.

It is also demonstrated by Table 3 that from the total root length of one-, two-, three-, four-, five- and six-year-old trees 76.2, 84.6, 83.3, 77, 86.5 and 81 per cent were located within the drip. In contradistinction to earlier practice these data prove clearly that the areas under the branch systems must regularly be provided with nutrients. In the course of his root investigations SUTA (1957) established that the great majority of 0 to 15 cm thick roots was located under the branch system. Considering this fact he demonstrated with dressing experiments that the development of trees was most satisfactory when organic manures and fertilizers were dispersed and worked into the soil in the areas under the crowns.

Location and distribution according to depth horizons of the root system of Jonathan apple trees grafted on M IV stock

The distribution according to the depth horizons of the examined 1- to 6-year old Jonathan apple trees grafted on M IV stock and growing in clay soil is presented in Table 4.

From the data of this table it may be seen that the depths reached by the root system of apple trees grafted on M IV stock and standing in clay soil vary according to age classes, i.e. with advancing age certain roots penetrate successively deeper into the soil. The greatest depth touched by roots at the age of one was 90 cm and in the 6th year 270 cm. The stability of apple trees

Table 4

Cumulative percentual quantity in different depths of the root system of 1- to 6-year-old Jonathan apple trees grafted on M IV stock and growing in clay soil

Depth horizonts cm	Percentual distribution of roots of trees (age)					
	1	2	3	4	5	6
0— 10	14.39	2.85	0.87	4.72	6.52	2.14
11— 20	66.74	30.24	10.10	19.23	31.82	16.47
21— 30	86.47	65.64	32.59	44.47	71.42	37.33
31— 40	94.39	86.32	54.02	64.88	89.88	52.72
41— 50	97.35	93.58	71.87	79.65	96.02	66.58
51— 60	98.87	95.78	83.10	86.69	97.81	79.66
61— 70	99.52	97.18	89.66	90.47	98.51	87.32
71— 80	99.89	98.13	94.70	93.67	98.98	91.87
81— 90	100.00	98.81	97.15	95.94	99.34	94.06
91—100	—	99.25	98.48	97.27	99.60	95.50
101—110	—	99.86	99.16	98.28	99.76	96.54
111—120	—	100.00	99.60	99.01	99.86	97.33
121—130	—	—	99.85	99.50	99.92	97.83
131—140	—	—	99.95	98.80	95.95	98.44
141—150	—	—	100.00	99.93	99.96	98.82
151—160	—	—	—	99.99	99.97	99.18
161—170	—	—	—	100.00	99.98	99.42
171—180	—	—	—	—	99.99	99.67
181—190	—	—	—	—	100.00	99.79
191—200	—	—	—	—	—	99.88
201—210	—	—	—	—	—	99.92
211—220	—	—	—	—	—	99.95
221—230	—	—	—	—	—	99.96
231—240	—	—	—	—	—	99.97
241—250	—	—	—	—	—	99.98
251—260	—	—	—	—	—	99.99
261—270	—	—	—	—	—	100.00

growing on clay soil depends, to a considerable degree, on the adequate quantity of geotropically developing roots (Fig. 3). If the number of such roots is small, and in case of otherwise shallow rooting stocks, grafts are inclined to premature lodging, especially on fairly heavy, unfavourably aerated soils of rainy and windy regions. Due to such reasons, periodic deeper soil cultivations seem of importance in order to promote the penetration of the root system into greater depth. ZAPRAGAEVA (1952) examined the root system of

wild apple trees in Tadzhikhistan and found that if — owing to any cause — young apple trees are unable to develop deeply penetrating roots, the trees perish very soon.

Table 4 also reveals that from the root system of spindle-bushy Jonathan trees grafted on M IV stock and standing in clay soil at the age of one, two,

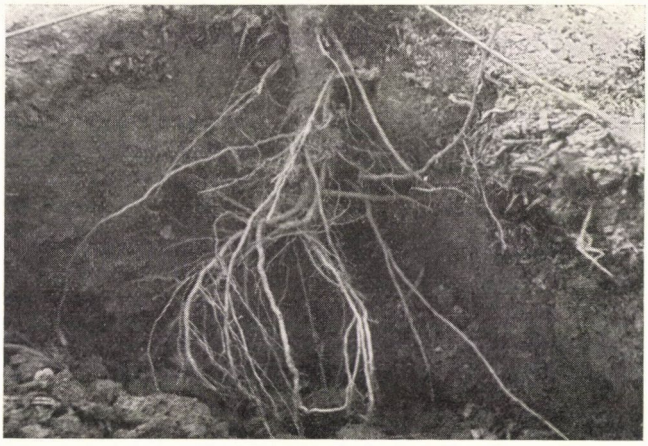

Fig. 3. The geotropically growing roots penetrating into the loosened soil of the former planting hole are clearly visible

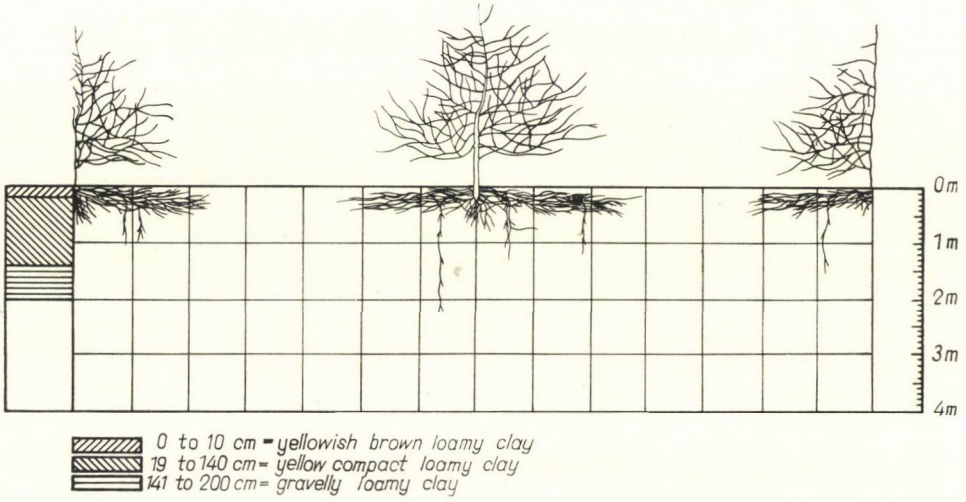

Fig. 4. Lateral view of the root system of five-year-old spindle-bushy Jonathan apple trees, grafted on M IV stock and planted in clay soil with 7×4 m spacing. The side of squares is 1 m long. The picture demonstrates the location of the root system in different depths

three, four and six 66.7, 30.2, 10.1, 19.2 and 16.4 per cent are located in the upper 0 to 20 cm soil layer, while from the roots of the five-year-old specimens 31.8 per cent occupy this horizon as a consequence of a more compact spot in

the subsoil. Knowing the root quantities located in the 0 to 20 cm depth of trees standing in fairly heavy soil it may be established as a rule that the depth of soil cultivation must not surpass 10 to 12 cm under the branch systems, and not 15 to 18 cm extending to some distance outside the drip.

In peripheral areas, reckoned a certain distance from the stem and depending on age, the soil can be safely cultivated to greater depths, because the root system of the apple tree has an excellent regeneration ability (Fig. 4). Similar observations were also made by POPOV (1963), who had examined the root system of seven-year-old apple trees grafted on dwarf stocks and standing in clay soil. According to this author, clay soil may be cultivated to a depth of 10 to 12 cm within a circle of 1 m radius from the stem and to 12 to 15 cm at greater distances.

At the age of one, the mass of the root system (86.4 per cent) was located 0 to 30 cm deep, in the second year 83.4 per cent were found at 11 to 40 cm, in the 3rd 71 per cent at 11 to 50 cm, in the 5th 83 per cent at 11 to 40 cm and in the 6th year 77.5 per cent at 11 to 60 cm depth.

The data on the location of the greatest part of roots in different depths give real advice as to the most convenient profile to be soaked by nutrient solutions and irrigation.

REFERENCES

GHENA, N. (1961): Aplicarea agrotechnicii inlivezi in functie de sistemul radicular de pomilor. Gradina, Via si Livada Revista de stiinte sipractica hortiviticulturale. **10,** 3, 35—39.

HILKENBÄUMER, F. (1959): Spross- und Wurzelkronenentwicklung verschiedener Obstsorten während der ersten sechs Standjahre auf Lehmboden. Der Erwerbsobstbau. Berlin—Hamburg. **1,** 7, 127—132.

KEMMER, E. (1947): Die Gestaltung der Wurzelkrone bei Obstgehölzen. Erw. Obstbau. Berlin, **4,** 208—212.

KERNER, A. (1888): Pflanzenleben. Leipzig.

KOLESNIKOV, V. A.—Колесников, В. А. (1958): Корневая система плодовых и ягодных пород. Вестник С/х Науки. Москва, **3,** 64—71.

KVARAZKHELIA, T. (1930): Beiträge zur Biologie des Wurzelsystems der Obstbäume. Die Gartenbauwissenschaft. **4,** 241—341.

POPOV, B. A.—Попов, Б. А. (1963): Корневые системы слаборослых подвоев в Подмосковье. Доклады ТСХА, **83,** 149—156.

PROBOCSKAI, E. (1959): Faiskola (Nursery). Mezőgazdasági Kiadó, Budapest, 230—234.

ROEMER, T. H.—HILKENBÄUMER, F. (1937): Wurzelstudien an 25jährigen Kernobstbäumen. Kühn Archiv., **42,**

SUTA, A. (1957): Zona cea mai efecienta de alpicare a ingrasa mintеior in livezile de mar cu solul intelenit. Lucrari stiintifice di Cursul anului. Bucuresti. Ed. Agr. Silv. de Stat., 267—275.

SUTA, A.—MODORAN, I.—DUMITRACHE, I. (1957): Contributii la studiul systemului reculrar al pomilor. Anale Inst. Cerc. Agron. Acad. R.P.R. Bucureşti, **24,** 429—457.

ZAPRAGAEVA, V. J.—Запрагаева, В. Й. (1952): Корневые системы некоторых дикорастущих плодовых Таджикистана. Бюлл. Московского общ. испытателей природы. Москва, **57,** 32—48.

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NUCLEIC ACID CHANGES DURING THE VEGETATIVE PERIOD IN THE LEAVES OF CERTAIN WOODY PLANTS AS A RESPONSE TO MUTAGEN TREATMENTS

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Total nucleic acid (total-NA), ribonucleic acid (RNA) and deoxy-ribonucleic acid (DNA) determinations were carried out in 1961 and 1963 in leaves of almond, apricot and peach seedlings grown from seeds treated with mutagen. According to our investigations nucleic acid results were fairly uniform concerning the three fruit-tree species. Examinations in 1961 showed in most cases a decrease of total-NA in almond seedlings treated with mutagen (colchicin, liquid air, Co^{60} irradiation) as compared to the control. During the examinations of 1963 the amount of the total-NA was high at the beginning of the vegetative period, then gradually decreased and finally stagnated. In the whole period of examination it was the DNA content that showed the lowest fluctuation in all the three fruit-tree species.

Introduction

Interest in studying the physiological nature of mutagen effects (BOWEN 1962) and their practical utilization (KUZIN 1962, SURREY 1965) has recently ncreased. On the basis of our knowledge of molecular biology it seems obvious that treatments causing profound genetic — and even before supposedly metabolic — changes affect also the protein and nucleic acid metabolism of cells (WEISS 1964, DUBININ 1965).

Starting from this postulate we performed nucleic acid examinations during the vegetative period in leaves of woody plants (almond, apricot, peach) treated with various mutagenic agents (liquid air, colchicin, Co^{60} irradiation) in order to determine the changes in the nucleic acid content.

Materials and Methods

Mutagen treatments applied to woody plants were started in 1956 at the Department of Plant Heredity and Plant Breeding of the University of Horticulture. (Seeds of almond, apricot and peach species were treated at that time.)

The treatments were as follows: Co^{60} irradiation — 800 and 1200 r respectively —, liquid air — dry seed treatment for 30 minutes — and colchicin — 0.1—0.5 per cent.

The above treatments were applied to seeds of the following almond varieties: 1. Burbank, 2. Óriáskagyló, 3. Diósdi. In apricot Korai-kajszi while in peach the Elberta types were the objects of the examination. (The last two were given only colchicin treatments.)

Liquid air and colchicin treatments were carried out at the Department of Plant Heredity and Plant Breeding of the University of Horticulture, while cobalt irradiation at the Na-

tional Oncological Institute. After the treatments seeds were planted in the Szigetcsép Model Farm of the University. Examinations of the nucleic acid content in the leaves of almond, apricot and peach seedlings grown from treated stones began in 1961. Almond seedlings were 3 years, apricot seedlings 5 and peach seedlings 4 years old at that time.

Determinations were carried out by Hammerstein's method described by KOVÁCS (1958). Concentrations of nucleic acids were obtained by means of a calibration curve constructed at our Institute (MOLNÁR 1964) on the basis of extinctions read on the Uvifot photometer at a wave-length of 254 millimicron. The usefulness of the Uvifot-photometer in determining nucleic acid concentrations was made certain by comparative measurements made with the English Unicam Sp 500 spectrophotometer. Detailed data and results concerning the comparative measurements were presented in an earlier publication (MOLNÁR 1964).

For nucleic acid examinations leaves were collected from the II. storeys of trees, all round in the directions of all cardinal points. To obtain adequate average samples 40—50 leaves were required which could not be provided for from one side only.

On a single occasion, on 5th May 1964 we made an additional sampling: we collected small young almond terminal leaves. Determinations were carried out in dry matter in almost every month.

Results

Nucleic acid contents of leaves of almond seedlings examined in 1961 (total-NA, RNA, DNA) are presented in Table 1. Only three data for each are available from this year, still it is clear from them that in the case of the

Table 1

Nucleic acid content in g per cent in the leaves of almond seedlings related to dry matter content
1961

Treatments	Total-NA			RNA			DNA		
	time of examinations								
	31. V.	4. VII.	2. VIII.	31. V.	4. VII	2. VIII.	31. V.	4. VII.	2. VIII.
Diósdi									
Control	1.67	1.23	1.20	1.54	1.10	1.10	0.13	0.13	0.10
Liquid air	1.14	0.86	1.12	0.99	0.80	0.99	0.15	0.06	0.13
0.2 per cent colchicin	1.02	1.06	1.27	0.82	0.99	1.10	0.20	0.07	0.17
Co^{60} 800 r	0.94	0.90	0.97	0.80	0.82	0.84	0.14	0.08	0.13
Co^{60} 1200 r	1.06	0.97	1.19	0.97	0.90	1.06	0.09	0.07	0.13
Óriáskagyló									
Control	1.44	1.10	0.88	1.08	0.94	0.80	0.36	0.16	0.08
Liquid air	1.06	0.82	0.81	0.88	0.80	0.60	0.18	0.02	0.22
0.2 per cent colchicin	0.99	0.80	0.74	0.84	0.72	0.60	0.15	0.06	0.14
Co^{60} 1200 r	0.88	0.82	0.76	0.82	0.78	0.60	0.06	0.04	0.16
Burbank									
Control	1.04	0.88	1.04	0.90	0.80	0.99	0.14	0.08	0.05
Liquid air	1.31	0.94	0.94	1.02	0.82	0.88	0.29	0.12	0.06
0.2 per cent colchicin	1.04	0.80	0.82	0.94	0.68	0.60	0.10	0.12	0.22
Co^{60} 800 r	—	0.74	0.86	—	0.59	0.80	—	0.15	0.06
Co^{60} 1200 r	1.04	1.12	0.84	0.60	0.88	0.78	0.44	0.24	0.06

varieties Diósdi and Óriáskagyló on the days of examinations total-NA content in the leaves of all seedlings examined was lower than that in the control, which is well seen in Fig. 1. In the case of the variety Burbank the trend of the total-NA content is not so unambiguous.

RNA content in the seedlings of the almond varieties shows trends similar to those mentioned above, that is to the total-NA trends. In this case too, RNA content of the treated plants is lower than that of the control.

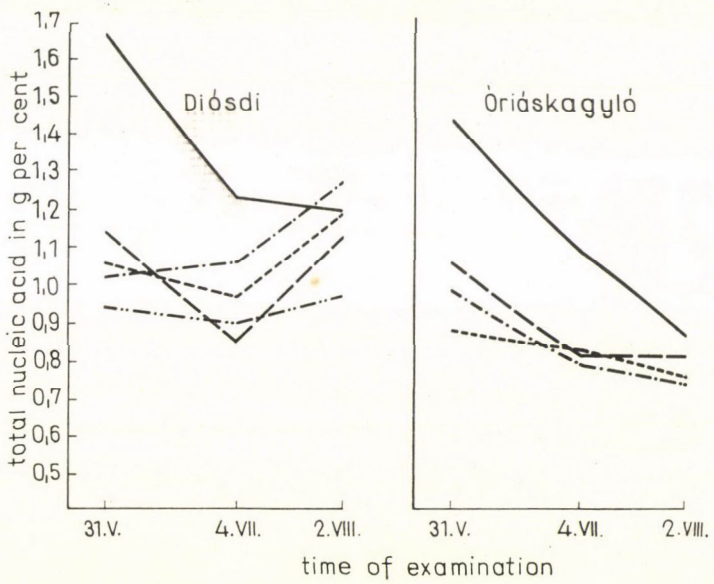

Fig. 1. Total nucleic acid content in the leaves of almond seedlings treated with mutagens expressed in g per cent related to dry matter content. Szigetcsép, 1961. (———— control, — — — liquid air, —.—.—.—.— 0.2 per cent colchicin, —..—..—..— Co^{60} 800r , ... Co^{60} 1200 r)

Both total-NA and RNA contents of leaves of all three almond varieties — including controls and treated seedlings — show a decreasing tendency with the progress of the season. TURKOVA (1964) and SHAW *et al.* (1965) found the same results with other plants.

Total-NA contents of leaves of the almond seedlings Diósdi and Óriáskagyló examined in 1963 are shown in Fig. 2. It reveals that in the seedlings of the examined almond varieties (including Burbank) total-NA content of leaves was high at the beginning of the season, then gradually decreased until the next examination on July 2. From this time on, between July 2 and September 2, a stagnation was observed in the total-NA content with major or minor increases dependent on variety and treatment.

In the variety Diósdi the total-NA content in the leaves of the treated seedlings generally remained below the control — as in 1961. In the case of

the varieties Óriáskagyló and Burbank the total-NA contents vary according to treatments and examinations; there are values both higher and lower than those of the control.

In the variety Óriáskagyló the total-NA content of the specimen treated with liquid air, while remaining considerably below in 1961, was, in 1963, nearly at the same level as that of the control during the whole period of examination.

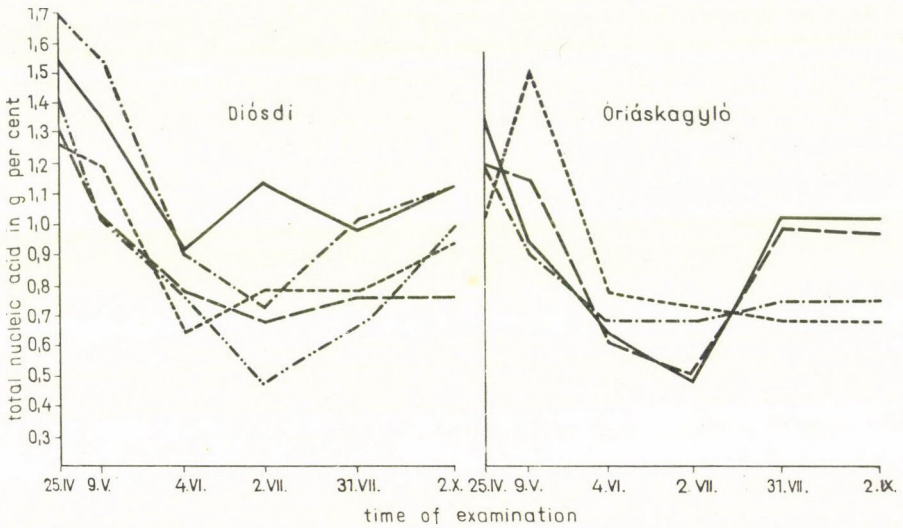

Fig. 2. Total nucleic acid content in the leaves of almond seedlings treated with mutagens, expressed in g per cent, related to dry matter content. Szigetcsép, 1963. (———— control — — — — liquid air, —.—.—.— 0.2 per cent colchicin, —..—..—..— Co^{60} 800 r, ... Co^{60} 1200 r)

RNA and DNA contents of the leaves of almond seedlings are included in Table 2. According to our investigations the change in the RNA contents showed a tendency similar to that of total-NA contents in both 1961 and 1963. In all three almond varieties DNA contents of treated plants were the same as that of the control. A considerable part of the experimental data is, however, lower than that of the control. Only in the variety Burbank are the initial DNA contents of the two irradiated specimens and of the one treated with colchicin relatively high.

Results of nucleic acid examinations of apricot leaves in 1963. Total-NA trends during the vegetative period of apricot leaves treated with colchicin solution of 0.1 per cent concentration are shown in Fig. 3. In this case too, similar to the almond leaves, total-NA contents showed a decreasing tendency with the progress of the season — development and senescing of leaves. (This was the case with the other two pairs of samples examined too.)

Table 2

Nucleic acid content in g per cent in the leaves of almond seedlings related to dry matter content
1963

Treatments	RNA						DNA					
	25. IV.	9. V.	4. VI.	2. VII.	31. VII	2. IX.	25. IV.	9. V.	4. VI.	2. VII.	31. VII	2. IX.
Diósdi												
Control	1.35	1.14	0.74	0.86	0.72	0.86	0.19	0.21	0.18	0.28	0.27	0.26
Liquid air	1.10	0.94	0.56	0.54	0.48	0.54	0.21	0.12	0.22	0.14	0.28	0.22
Colchicin (0.2 per cent)	1.44	1.27	0.59	0.52	0.72	0.99	0.25	0.27	0.31	0.20	0.36	0.13
Co^{60} 800 r	1.27	0.92	0.54	0.35	0.27	0.68	0.13	0.10	0.22	0.13	0.39	0.29
Co^{60} 1200 r	1.14	1.04	0.54	0.56	0.56	0.68	0.13	0.15	0.11	0.22	0.22	0.25
Óriáskagyló												
Control	0.99	0.86	0.52	0.35	0.65	0.76	0.34	0.08	0.13	0.13	0.41	0.32
Liquid air	0.94	0.92	0.50	0.39	0.59	0.65	0.25	0.22	0.12	0.11	0.40	0.31
Colchicin (0.2 per cent)	1.08	0.78	0.60	0.52	0.48	0.52	0.12	0.12	0.08	0 16	0.26	0.23
Co^{60} 1220 r	1.04	1.40	0.70	0.48	0.37	0.48	0.04	0.10	0.18	0.24	0.31	0.19
Burbank												
Control	1.14	1.17	0.99	0.39	0.44	0.56	0.09	0.10	0.21	0.33	0.21	0.28
Liquid air	1.23	1.54	0.76	0.41	0.52	0.65	0.02	0.13	0.12	0.24	0.20	0.12
Colchicin (0.2 per cent)	1.25	0.90	0.56	0.33	0.52	0.56	0.25	0.29	0.06	0.31	0.22	0.22
Co^{60} 800 r	1.78	0.94	0.74	0.46	0.65	0.54	0.29	0.12	0.10	0.27	0.22	0.16
Co^{60} 1200 r	1.67	0.72	0.74	0.30	0.60	0.50	0.40	0.14	0.10	0.36	0.26	0.18

TÉTÉNYI (1964) found the same results when examining the total-NA content of apricot buds. She pointed out, that from the time of bud differentiation until January the nucleic acid content of buds was low, while by the time the vegetation started a very large amount of nucleic acid accumulated.

In our investigations too, it was at the beginning of the season that leaves contained the maximum nucleic acid in all three fruit tree species. With TÉTÉNYI's data (on changes in the total nucleic acid content of buds) and our data on the examined leaves put side by side a steep curve is obtained which gives information on nucleic acid trends in woody plants during the whole year.

Results obtained in 1963 concerning the RNA and DNA contents of apricot leaves are included in Table 3. The DNA content — as contrasted with the total-NA content — showed an increasing tendency during the vegetative period in the K—1 and K—2 apricot samples (both in those treated

with colchicin and in the control). With lower concentration this increase seemed to be more intensive than with the 0.2 per cent concentration. In both cases, however, DNA content of treated plants remained below, or was close to that of the control. In the 0.5 per cent treatment DNA contents — similarly

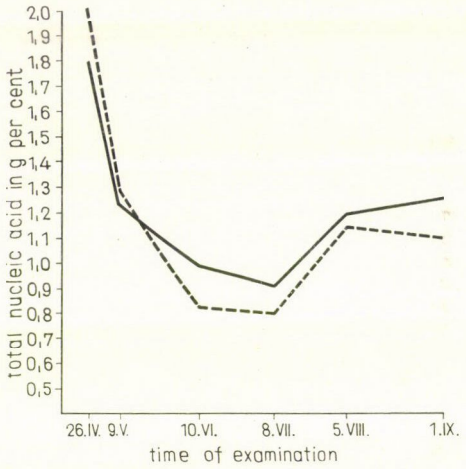

Fig. 3. Total nucleic acid content in the leaves of K—1 apricot seedlings treated with colchicin, expressed in g per cent, related to dry matter content. Szigetcsép, 1963. (———— control, — — — — 0.1 per cent colchicin)

Table 3

Nucleic acid content in g per cent in leaves of colchicin treated apricot seedlings related to dry matter content
1963

Treatments	26. IV.	9. V.	10. VI.	8. VII.	5. VIII.	10. IX.
	RNA					
K—1 control	1.61	1.10	0.78	0.46	0.90	0.82
K—1 0.1 per cent colchicin	1.91	1.25	0.65	0.46	0.88	0.78
K—2 control	1.91	0.99	1.17	0.60	1.25	0.68
K—2 0.2 per cent colchicin	2.24	0.86	0.99	0.68	1.08	0.44
K—3 control	2.24	1.08	1.14	0.50	0.86	0.35
K—3 0.5 per cent colchicin	2.20	1.20	0.99	0.88	1.20	0.56
	DNA					
K—1 control	0.19	0.13	0.21	0.45	0.29	0.43
K—1 0.1 per cent colchicin	0.11	0.04	0.17	0.34	0.26	0.32
K—2 control	0.10	0.24	0.21	0.31	0.29	0.31
K—2 0.2 per cent colchicin	0.16	0.16	0.34	0.36	0.30	0.26
K—3 control	0.42	0.09	0.24	0.30	0.28	0.19
K—3 0.5 per cent colchicin	0.56	0.24	0.26	0.37	0.34	0.33

to the total-NA contents — were above those of the control at all dates of examination.

RNA and DNA contents examined in 1963 in leaves of B—2 peach seedlings treated with a 0.2 per cent colchicin solution are shown in Fig. 4.

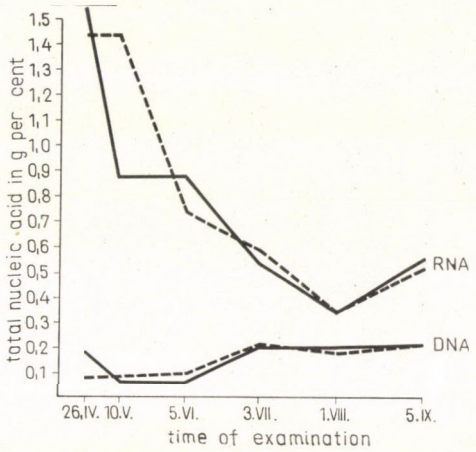

Fig. 4. Nucleic acid content of B—2 peach treated with colchicin, expressed in g per cent related to dry matter content. (———— control, — — — — 0.2 per cent colchicin)

Nucleic acid changes show tendencies similar to those in seedlings of the two other fruit-tree species.

According to our examinations nucleic acid contents — both total-NA and RNA — in the leaves of peaches treated with colchicin were about the same as those in the control. The trend of the total-NA curve — both for treated plants and the control — corresponds to that of the RNA-curve.

Data on the NA contents of small and young terminal almond leaves examined on one occasion on May 5, 1964, are presented in Table 4.

Table 4

Nucleic acid content in g per cent in small and young terminal leaves of almond seedlings related to dry matter content
1964

Treatments	Total-NA	RNA	DNA
	5. V.		
Óriáskagyló			
Control	3.34	2.28	1.06
Liquid air	3.18	2.40	0.78
0.2 per cent colchicin	3.90	3.08	0.82

According to the data obtained in the small and young terminal leaves of almond seedlings total-NA and RNA contents are about twice, and DNA contents about three to four times as much as in almond leaves examined in series at thesame time. Our examinations performed so far suggest that it is the terminal leaves that have the highest nucleic acid content. HACHIDZE *et al.* (1964) obtained similar results by finding the highest nucleic acid content in the terminal buds of shoots of one-year-old and older vines.

Discussion

Total-NA, RNA and DNA contents in the leaves of almond, apricot and peach seedlings were examined on several occasions during the vegetative period in 1961 and 1963. The examinations gave rather uniform results concerning the nucleic acid contents of seedling leaves in all three fruit-tree species.

According to the results obtained in 1961 (as a response to colchicin, liquid air and Co^{60} irradiation treatments) the amount of total-NA in the leaves of all three almond seedlings decreased in most cases as compared to the control.

It was described by VÁRTERÉSZ (1963) and by now it has been proved that various tissues have reduced nucleic acid contents after irradiation. Similarly in 1961 RNA contents in the individual almond species showed the same trends as total-NA contents did.

According to our experiments performed in 1963 the amount of total-NA was uniformly high in all three almond species at the beginning of the vegetative period, gradually decreased till July 2 and then became stagnant. HACHIDZE *et al.* (1964) on the basis of experiments performed with vine pointed out that in the organs of bearing vines nucleic acid content was highest in spring, at the beginning of the vegetative period, then gradually decreased.

There is a two-year difference between our NA examinations carried out in 1961 and 1963. In our opinion it is probable that unfavourable mutagenic effects — manifested in the reduced amounts of nucleic acids — observed in the earlier year were partly or completely overcome by the individual almond seedlings. NA contents in the leaves of these plants were close to, or even exceeded, those of the control.

Nucleic acid results of apricot leaves in 1963 were the same as those of almond leaves; total-NA content showed a decreasing tendency with the progress of the season, development and senescing of the leaves.

According to data obtained in 1963 nucleic acid contents — total-NA, RNA and DNA — in the leaves of B—2 peach seedlings treated with a 0.2 per cent colchicin solution were the same as those of the control.

Of the three fruit-tree species examined in 1963 it was apricot which had the highest total-NA content in leaves.

Nucleic acid data of almond and peach leaves are of about the same order at the individual dates.

During the whole period of examination DNA content showed the lowest fluctuation in the seedlings of all three species. STOLETOV (1964) too, though in an agricultural plant, found similar results.

Examinations carried out in 1964 showed the highest total-NA, RNA and DNA contents in the young terminal leaves of almond seedlings (HACHIDZE *et al.* 1964, TÉTÉNYI 1964).

Acknowledgement

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REFERENCES

BIRÓ, E.—FEDORCSÁK, I. (1959): Kézikönyv az Uvifot-fotométer használatához (Handbook for the use of the Uvifot-photometer). MOM Budapest.

BOWEN, H. J. M. (1962): Radiosensitivity of higher plants and correlations with cell weight and DNA content. Radiat, Bot., London. I. **3**, 223—228.

DUBININ, N. P.—Дубинин, Н. П. (1965): Некоторые вопросы современной генетики. Природа, Москва, **8**, 11—19.

HACHIDZE, O. T.—KACHARAVA, A. V.—Хачидзе, О. Т. — Качарава, А. В. (1964): Количественное изменение нуклеиновых кислот в виноградной лозе. Сообщ. А. Н. Грузинской ССР. Тбилиси, **34**, 359—366.

KOVÁCS, A. (1958): A kísérleti orvostudomány vizsgáló módszerei (Testing methods of experimental medicine). IV. Akadémiai Kiadó, Budapest.

KUZIN, A. M.—Кузин, А. М. (1964): К теории предпосевного гаммаоблучения семян. Биол. основы повышения качества семян с/х растений. Москва, Изд. «Наука», 160—167.

MOLNÁR, I. (1964): Uvifot-fotométer alkalmazhatósága nukleinsavak mérésénél növényi objektumokon (Usefulness of Uvifot-photometers in measuring nucleic acids in plants). Agrokémia és Talajtan, **13**, 291—298.

SHAW, M.—BHATTACHARYA, P. K.—QUICK, W. A. (1965): Chlorophyll protein and nucleic acid levels in detached, senescing wheat leaves. Canad J. Bot., **43**, 739—746.

SURREY, K. (1965): Modification of the relationship between growth and metabolism in seeds by X-radiation. Radiation Res., **25**, 470—479.

STOLETOV, V. N. *et al.*—Столетов, В. Н. и др. (1964): Характер варьирования содержания нуклеиновых кислот в зародышах семян разных пшениц. Докл. А. Н. СССР. Москва, **158**, 963—966.

TÉTÉNYI, P. (1964): Fás növények nyugalmi állapotának összefüggése a légzéssel és foszforanyagcserével (Relationship of dormancy to respiration and phosphorus metabolism in woody plants). Kertészeti és Szőlészeti Főiskola Közleményei, **1**, 137—147.

TURKOVA, N. S.—Туркова, Н. С. (1964): Изменения нуклеинового обмена в онтогенезе растений при разных условиях выращивания. Биол. Нуклеин. Обм. Раст., **2**, 85—89.

VÁRTERÉSZ, V. (1963): Sugárbiológia (Radiobiology) Medicina. Budapest.

WEISS, J. J. (1964): Chemical effects of ionizing radiations on nucleic acids and related compounds. Progress in nucleic acid research and molecular biology. Acad. Press, New York, **3**, 103—144.

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EFFECT OF PETROLEUM MULCH ON COTTON GROWTH

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Field experiments have been conducted to study the effect of petroleum mulch on the rates of germination, flowering, fruiting and cotton yields.

Petroleum mulch has been found to increase soil temperatures with several degrees, which enhanced earliness in cotton growing by accelerating the germination and fruiting of the plants that resulted in increased cotton yields. Mulching was also found to be a good weed controller and mulched areas needed a minimum of cultivation.

Introduction

Cotton, though one of Egypt's most important crops, is limited in production due to several prime factors in which damages caused in mid or late season by certain diseases and insects play a prominent role. Compared to the preboll-worm era of forty or fifty years ago, the present day deficit in yield due to these limiting factors has induced cotton breeders to develop earlier maturity variety of cotton.

However, economic and labour factors associated with the harvesting of cotton also emphasize the need for greater earliness and one of the methods used for this purpose is the application of mulches.

The use of mulches in agriculture dates back to ancient history when the use of materials such as straw and sand had been recognized as means of enhancing plant growth by retarding soil evaporation.

Recently plastic mulches have been successfully used to reduce surface evaporation (HONMA *et al.* 1959, PETERS—RUSSELL 1959, SHAW 1959, WILLIS 1962, BENNETT *et al.* 1966), which may account for as much as fifty per cent of the total moisture lost from the soil and also to increase early season soil temperatures (EMMET 1957, CLARKSON 1960, WAGGONER *et al.* 1960, ADAMS 1962) in order to induce earliness in growing.

Moreover, it was found that the growth rate of tomato plants was increased with soil moisture content and increased temperature. Other workers (CLARKSON 1960, BLACK—GREB 1962) have shown that an increase in soil nutrient availability especially NO_3—N and P were also obtained.

In the last few years several research workers in the petroleum field had been experimenting with petroleum mulches (PHILLIPS—FRANS 1965, SIEGEL *et al.* 1967) with such encouraging results that a commercial product was put on the market.

Material and Method

The work presented here was conducted in 1966 on a farm at Kirsa, Gharbieh District, U.A.R., using "Menoufi" variety of cotton (*Gossypium barbadense* L.).

In a randomized block design of four replications, plots consisted of four signal rows with fifty hills on each spaced 30 cm apart. Five seeds were planted in each hill which were thinned into two plants after they had emerged. Planting dates were February 1, February 20 and March 11.

Immediately after planting, petroleum mulch obtained from a resinous petroleum fraction was sprayed as a water emulsion on the top of alternating rows as a thin film in bands 25 cm wide and about 0.05 cm thick. The non-sprayed rows were used as control ones.

A superphosphate fertilizer was applied to all plots before planting and after thinning.

Soil and air temperatures were taken every ten days with a high temperature recording at 1.30 p.m. and a low temperature recording at 5 a.m. Soil temperatures were taken 3 cm in the ground, and air temperatures 50 cm above ground level.

The rates of germination, plant height, flowering, fruiting and cotton yields were recorded.

Results and Discussion

Soil temperatures. Results shown in Table 1 indicate that petroleum mulch applied in 25 cm bands has significantly increased soil temperatures. Minimum temperatures were increased by mulching by as much as 5.4°C

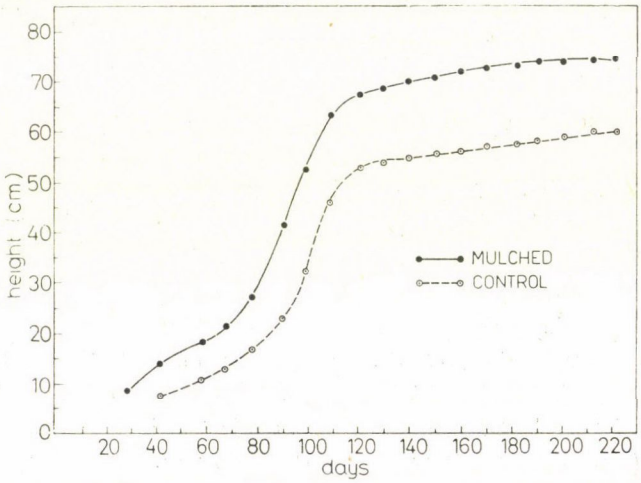

Fig. 1. The height of the mulched plants (Planting date: Feb. 1)

and maximum temperatures by 3.5°C thus raising the average temperature of the soil during the two crucially cold months, February and March, maintaining it at a more favourable temperature range for plant growth.

Plant growth. The petroleum mulch was found to increase seedling emergence of the early planted cotton, on Feb. 1 and 20, but its effect was not so pronounced at the later planting date of March 11. The increase of soil moisture

Table 1

Air and soil temperatures with and without petroleum mulch

Date	Low temp. °C				High temp. °C			
	Air	Soil	Mulched soil	Diff.	Air	Soil	Mulched soil	Diff.
Feb.								
1	7.7	9.1	14.5	5.4	18.0	22.3	25.5	3.2
10	9.6	11.5	16.7	5.2	20.5	22.5	25.8	3.3
20	9.5	11.7	16.8	5.1	19.3	22.1	25.6	3.5
March								
1	9.6	11.8	15.7	4.9	24.3	27.4	30.1	3.1
10	9.0	11.3	15.4	4.1	29.1	31.2	33.9	2.7
20	8.4	11.2	15.5	4.3	16.7	18.9	21.8	2.9
April								
1	10.6	12.4	17.1	4.7	21.6	25.8	28.3	2.5
10	10.7	12.9	17.5	4.6	27.1	30.3	33.1	2.8
20	12.2	14.8	19.7	4.9	24.3	28.9	31.2	2.3
May								
1	17.3	17.9	21.2	3.3	33.5	36.9	39.0	2.1
10	14.5	16.6	20.1	3.5	29.2	33.1	35.0	1.9
20	18.2	19.7	22.5	2.8	27.2	31.0	32.5	1.5
June								
1	20.1	22.5	25.0	2.5	38.5	42.2	43.3	1.1
10	20.5	23.1	24.6	1.2	33.2	34.9	36.7	1.8
20	20.3	22.7	23.9	1.2	32.4	33.5	34.5	1.0
July								
1	18.9	21.4	22.2	0.8	31.9	32.8	33.4	0.6
10	20.5	22.9	23.6	0.7	36.8	37.2	37.7	0.5
20	21.9	23.7	27.1	0.4	37.2	37.5	37.8	0.3
August								
1	21.5	23.2	23.3	0.1	32.1	29.3	29.3	0.0

and temperature enhanced rapid germination and plant growth which resulted in plants several centimeters higher than unmulched plants at the end of the season. As planting dates have been advanced, the near maximum height of the mulched plants has also advanced (Figs 1, 2 and 3).

Flowering. The number of flowers produced per plant was recorded every ten days and the results show that most of the plants flowered starting on May 15 to July 12 irrespective of planting date. However, mulching caused an increase in the number of flowers produced per plant.

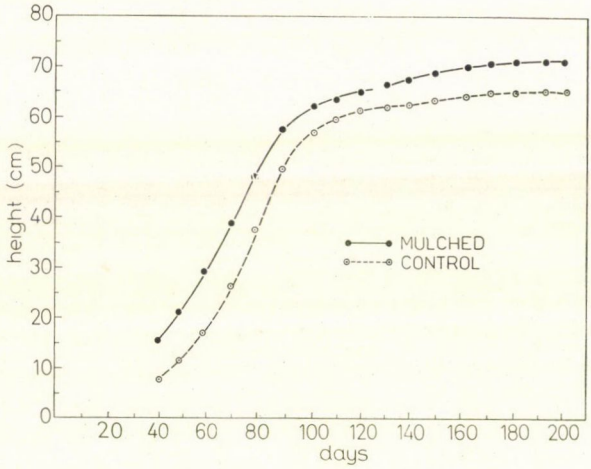

Fig. 2. The height of the mulched plants (Planting date: Feb. 20)

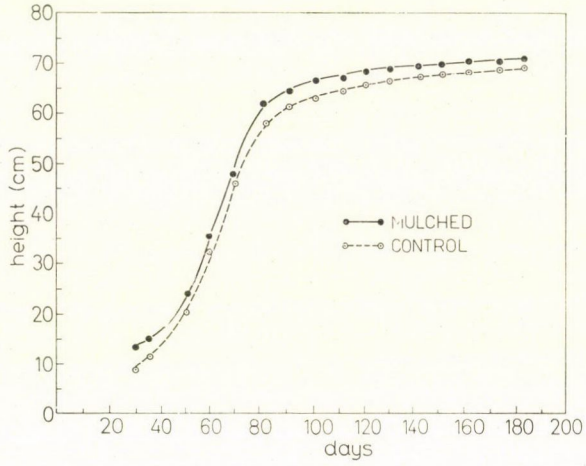

Fig. 3. The height of the mulched plants (Planting date: March 11)

Boll production and cotton yield. The total number of bolls produced was recorded and the boll setting percentage was derived from the equation:

$$\frac{\text{Total No. of bolls}}{\text{Total No. of flowers}} \times 100.$$

The boll shedding percentage was derived from the following operation after counting the final number of mature bolls at the end of the harvest:

$$\frac{\text{Shed bolls}}{\text{Total bolls}} \times 100.$$

All calculations were based on an average of fifty plants and the results in Table 2 show that though the boll shedding percentages and the number of mature bolls were higher in the two earlier planting dates, the difference

Table 2

Results showing the effect of petroleum mulching

Planting date	Feb. 1		Feb. 2		March 11	
	Control	Mulch	Control	Mulch	Control	Mulch
Total number of flowers	25.2	41.2	31.6	38.4	34.6	36.8
Total number of bolls	21.3	37.6	27.8	35.8	30.3	34.1
Setting per cent	84.5	91.3	88.1	83.2	87.6	92.7
Number of mature bolls	13.4	25.2	19.0	26.5	21.4	24.8
Boll shedding per cent	37.3	32.9	35.4	26.1	29.5	27.2
Seed cotton (g/plant)	11.69	19.34	12.98	17.72	13.29	17.63
Seed (g/plant)	8.16	13.02	8.78	11.85	8.93	11.82

between mulched and unmulched plots were significantly different. This difference became smaller the later the planting date.

In all planting dates the weight of the seed per plant was higher in the case of the mulched plots.

Weed control. The petroleum mulched areas needed no cultivation during the whole season and weeds did not germinate through the mulch film. The areas neighbouring the mulched ones were found to contain a much smaller amount of weeds than the normal and were cultivated three times during the season compared to the usual six or seven.

Conclusions

Petroleum mulching was found to influence two environmental factors that are essential to plant growth, soil temperature and moisture content, due to the formation of a low porosity film which prevents moisture evaporation from the seed zone and by increasing its temperature by several degrees over that of the bare soil. The benefits of petroleum mulching include the following: Promotion of a uniform and fast seed germination period leading to earlier yields. Reduction of surface evaporation benificial to desert areas of sparse rainfall or limited irrigation facilities. Protection of the soil against erosion and soil crusting. Increasing of the soil's nutrient availability by reduction of the rate of leaching acts as a weed control and eliminates the need for extensive cultivation during the growing season.

Acknowledgement

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REFERENCES

Adams, J. E. (1962): Effect of temperature on grain sorghum growth and yield. Agron. J., **54,** 257—261.

Bennett, O. L.—Ashley, D. A.—Doss, B. D. (1966): Cotton responses to black plastic mulch and irrigation. Agron. J., **58,** 57—60.

Black, A. L.—Greb, B. W. (1962): Nitrate accumulation in soils covered with plastic mulch. Agron. J., **54,** 366.

Clarkson, V. A. (1960): Effects of black polyethylene mulch on soil and microclimate temperature and nitrate level. Agron. J., **52,** 307—309.

Emmet, E. M. (1957): Black polyethylene for mulching vegetables. Am. Soc. Hort. Sci. Proc., **69,** 494—496.

Honma-Shigema-McArdle, F.—Carew, J.—Dewey, D. H. (1959): Soil and air temperature as effected by polyethylene film mulches. Michigan Agr. Exp. Sta. Bull., **41,** 834—842.

Peters, D. B.—Russell, M. B. (1959): Relative water losses by evaporation and transpiration in field. Soil Sci. Soc. Am. Proc., **23,** 170—173.

Phillips, R. E.—Frans, R. E. (1965): Effect of petroleum mulch on growth and yield of cotton in eastern Kansas Univ. Ark., Fayetteville, Bull. 699. April.

Shaw, R. H. (1959): Water use from plastic covered and uncovered corn plots. Agron. J., **51,** 172—173.

Siegel, J. R.—Davidson, J. R.—Kaestner, A. M. (1967): Petroleum agricultural mulch. Div. of Pet. Chem. A.C.S. Preprints, **12,** E-5, April.

Waggoner, P. F.—Miller, P. M.—Deroo, H. C. (1960): Plastic mulching: principles and benefits. Conn. Ag. Exp. Sta. Bull., 634.

Willis, W. O. (1962): Effect of partial surface covers on evaporation from soil. Soil Sci. Soc. Am. Proc., **20,** 598—601.

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GROWTH INHIBITION OF INTERNODES IN PEAR SEEDLINGS BY CCC (2-CHLOROETHYL TRIMETHYLAMMONIUM CHLORIDE)

By

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Wild pear seedlings were treated with 10^{-4}, 10^{-3} and 10^{-2} M concentrations of CCC (2-chloroethyl trimethylammonium chloride). Each seedling was given 120 ml CCC solution and tap water respectively in the form of irrigation. CCC in a concentration of 10^{-2} M was proved to inhibit — even at 0.1 per cent level — the elongation of internodes. In treatments with 10^{-3} and 10^{-4} M concentrations the inhibitory effect was not permanent, in the 10^{-4} M treatment it did not even occur.

Introduction

TOLBERT (1960) was the first to report on the inhibitory effect of CCC on growth. Later CATHEY—STUART (1961) found that CCC inhibited growth in more plant species than other growth retardants did.

It was only later that investigations into the effect of CCC on fruit trees began. MODLIBOWSKA (1965, 1966) reported on CCC considerably shortening the length of internodes in one-year-old pear grafts when applied in May and inreasing at the same time the differentiation of fruit buds. "Coscia" pears grafted to quince stocks were treated with CCC by LORETTI—COLLINA (1965) who found a high growth inhibitory effect. Experiments generally showed that CCC had much higher effect on pear trees than on apple trees (DENNIS 1966, LEH 1967).

According to literary data CCC can be successfully used for growth inhibition in pear trees. In our experiment we wished to examine whether CCC is able to inhibit the growth of pear seedlings at juvenile stage, since no experiments with young pear seedlings have been reported so far.

Materials and Methods

Layered wild pear seeds were sown into sterile perlite placed in culture pots containing a little hot bed soil at the bottom. 120 seedlings of those emerged were placed into three complete blocks and the following treatments were conducted: control, CCC used in concentrations of 10^{-4}, 10^{-3} and 10^{-2} M, respectively. Treatments were carried out in the form of irrigation. Seedlings were given a daily amount of 10 ml CCC solution and tap water respectively for 12 days.

At the beginning of the treatment we measured the heights and counted the leaves of seedlings at a stage when the position of cotyledons was still horizontal but the leaves were

not yet unfolded. The measurements continued for seven weeks from the beginning of the treatment. From the heights and leaf numbers of pear seedlings we obtained the average length of internode which we analysed statistically.

Results

Under the influence of CCC treatments shoot growth of pear seedlings was inhibited, while in the number of leaves no significant change was found. Table 1 shows not only the average length of internode but also the heights and leaf numbers of seedlings. This clearly shows that CCC exerts the highest

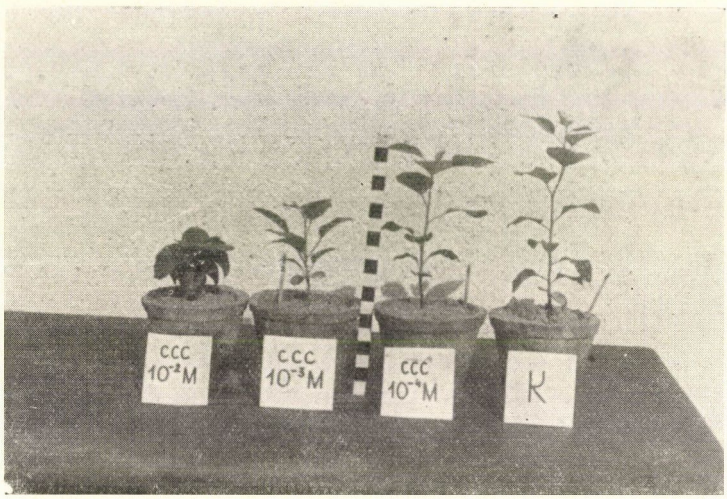

Fig. 1. Effect of various concentrations of CCC on the height of pear seedlings

inhibiting effect on the average internode length of pear seedlings in a concentration of 10^{-2} M, while at the same time it does not alter the number of leaves. In concentrations of 10^{-4} and 10^{-3} M CCC was of much lower effect which is proved by the significance countings as well. In the sixth week following the last treatment no significant differences were found as compared to the control.

The inhibiting effect of CCC on the elongation of internodes can be explained on the basis of the study of SACHS *et al.* (1960). Rooted cuttings of *Chrysanthemum morifolium* were soaked in AMO-1618 solution. Four days later they found that this quaternary ammonium derivative (CCC is also one of them) had an inhibiting effect on the subapical meristem, while the activity of the apical meristem remained normal. Inhibition of the tissue region controlling the elongation of internodes, and undisturbed activity of that controlling leaf formation (in fact, the selective effect of CCC is the same) will result in plants of rosette type after a treatment of effective concentration (10^{-2} M) (Fig. 1). 10^{-4} and 10^{-3} M concentrations of CCC are no more able

Table 1

Effect of various concentrations of CCC on the height, leaf number and average length of internode in pear seedlings (in mm and leaf number respectively)

Date of measuring	Heights of seedlings			
1967	Control	10^{-4} M	10^{-3} M	10^{-2} M
	concentrations			
15. March	28.8	26.1	21.4	5.6
22. March	42.6	40.4	29.9	9.7
29. March	71.8	71.3	50.3	11.8
5. April	90.4	79.3	80.5	13.3
12. April	94.5	86.6	96.4	15.4
19. April	105.7	90.4	102.8	19.0

Date of measuring	Number of leaves			
1967	Control	10^{-4} M	10^{-3} M	10^{-2} M
	concentrations			
15. March	4.1	4.3	4.4	5.5
22. March	5.2	5.3	5.3	4.2
29. March	7.3	7.7	7.3	6.5
5. April	8.4	7.9	9.2	7.6
12. April	10.4	10.4	11.8	10.1
19. April	11.0	10.9	12.3	10.7

Date of measuring	Length of internodes			
1967	Control	10^{-4} M	10^{-3} M	10^{-2} M
	concentrations			
15. March	7.02	6.07	4.86**	1.01***
22. March	8.19	7.62	5.64**	2.31***
29. March	9.83	9.25	6.89*	1.81***
5. April	10.76	10.03	8.75*	1.75***
12. April	9.08	8.32	8.16	1.52***
19. April	9.60	8.29	8.35	1.77***

* P = 5%
** P = 1%
*** P = 0.1%

to inhibit the activity of subapical meristem significantly. The lower effect is probably due to a peculiarity of CCC, namely, CCC — especially in lower concentrations — rapidly decomposes; the higher the rate of its decomposition, the lower its growth inhibitory effect (JUNG 1966, JUNG—EL-FOULY 1966). The reason why treatments of 10^{-4} and 10^{-3} M concentrations were not effective in our experiment was supposedly the same.

In the above experiment we succeeded to inhibit the internode elongation of juvenile pear seedlings at various degrees depending on concentration. As the number of leaves did not change considerably, the assimilating surface per unit shoot length increased.

REFERENCES

CATHEY, H. M.—STUART, N. W. (1961): Comparative plant growth retarding activity of AMO-1618, Phosfon and CCC. Bot. Gaz., **123,** 51—57.

DENNIS, F. G. (1966): Effects of growth retardants on juvenile apple seedlings. Proc. 17th Int. Hort. Congr. Md. 1, Abstr., 224.

JUNG, J. (1966): Das Verhalten von CCC in Pflanze und Boden. CCC Symposion, 135—47.

JUNG, J.—EL-FOULY, M. M. (1966): Über den Abbau von Chlorcholinchlorid (CCC) in der Pflanze. Z. Pflernähr. Düng. Bodenk., **114,** 128—34.

LEH, H. O. (1967): Wachstumsregulatoren im Obst-, Wein-, und Gemüsebau. Dtsch. Gartenbaumwirtschaft, **15,** 54—55.

LORETI, F.—COLLINA, F. (1965): Contributo allo studio dell'influenza erercata da alcuni prodotti „nannizzanti" su giovani piante di pero. Riv. Ortoflorofruttic. Ital., **49,** 443—52.

MODLIBOWSKA, J. (1965): Effects of CCC and gibberellic acid on growth, fruit bud formation and frost resistance in one-year-old pear trees. Nature, **208,** 503—504.

MODLIBOWSKA, J. (1966): Effect of GA and CCC on growth, fruit bud formation and frost resistance of blossoms of young Williams' bon chretien pears. East Mall. Res. Stn. Ann. Rep., **53,** 88—93.

SACHS, R. M. *et al.* (1960): Shoot histogenesis: Subapical meristematic activity in caulescent plants and the action of gibberellic acid and AMO-1618. Amer. J. Bot., **47,** 200—66.

TOLBERT, N. E. (1960): (2-chloroethyl) trimethylammonium chloride and related compounds as plant growth substances. I. Chemical structure and bioassay. J. Biol. Chem., **235,** 475—79.

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CONTRIBUTION TO THE GENETIC ANALYSIS OF THE AMPHIDIPLOID TRITICUM AESTIVO-TIMOPHEEVI

By

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F_1 and subsequent generations of the amphidiploid *T. aestivo-timopheevi* obtained by treating the interspecific hybrid of *T. aestivum* L. (ABD) $\times$ *T. timopheevi* Zhuk. (AG) with colchicine are analysed genetically. A certain relationship between the two species resulted in the segregation of various types in the F_2 and F_3 generations. Among the plants having a chromosome number of 2n = 70 there were some with a chromosome number of 2n = 56. Besides the compatibility and fertility relations of the segregated types their quantitative and qualitative features and characters were also studied.

Introduction

The practical value of a great number of naturally occurring polyploids called the researchers' attention to artificially produced polyploids too. Interest was raised even more when some authors (BECKER 1954, GYŐRFFY 1939, MÜNTZING 1955, OEHLER 1938, SEARS 1941, ZSEBRAK 1944, 1957, etc.) reported on methods by which sterility of hybrids of genetically different species can be partly or totally terminated.

Some authors made experiments with the polyploidization of *T. aestivum* L. $\times$ *T. timopheevi* Zhuk. hybrids. In the vast polyploid plant material produced by ZSEBRAK (1944, 1957) the new form of these two species obtained by colchicine treatment and known as *Triticum Borisovi* Zsebr. can also be found. This form back-crossed to *T. aestivum* L. results in the progeny with 2n = 70 chromosome number — so called sesquidiploids (2n = 56) possessing the diploid chromosome complement of *T. aestivum* L. and the haploid chromosome complement of *T. timopheevi* Zhuk. (ZSEBRAK—NIKOLSKIJ—MANKEVITS 1964). In these irregular types (CARENJA—NIKOLSKIJ 1966) abnormal cell division was observed at a frequency of 40 per cent. STEBBINS (1947) mentioned ploids of species in close relation with each other as "segregating allopolyploids".

Materials and Methods

The amphidiploid *T. aestivo-timopheevi* was produced in our institute in the autumn of 1954 by RAJHÁTHY—KISS by treating the F_1 hybrid grains of *T. aestivum* L. (F 481) $\times$ *T. timopheevi* Zhuk. with 0.02 per cent colchicine. Among the 18 ears of the plant grown in a greenhouse and transplanted in the next spring one ear became amphidiploid and produced 22 grains under the influence of the chemical.

Cytological examinations were carried out with squash preparations by using the rapid carmine-acetic acid method. Pollens were studied under a microscope at a magnification of 10×8. Pollens of regular shape, well stained in carmine-acetic acid are considered as fertile pollens.

Results

Compatibility. Back-crossing of *T. aestivo-timopheevi* amphidiploids to both parents is very difficult owing to the parent species being genetically isolated. This fact was confirmed by the crossing data of 1957 and 1958, when seed setting percentages of 9.5 and 0.8 respectively were obtained from back-crossing to the F 481 parent variety (Table 1).

Table 1

Back- and top-crossing data of the T. aestivo-timopheevi amphidiploid

Year	Combination	Crossed flower	Obtained grain number	Seed setting %	Germination %
1956	amphidiploid × F 481	386	0	0	0
1957	amphidiploid × F 481	63	6	9.5	33.3
1958	amphidiploid × F 481	364	3	0.8	66.6
1959	amphidiploid × F 481 BC_2	162	4	2.5	50.0
1958	amphidiploid × *T. timopheevi*	302	0	0,0	0.0
1958	*T. timopheevi* × amphidiploid	64	4	6.3	25.0
1958	amphidiploid × *T. carthlicum*	196	0	0.0	0.0
1959	amphidiploid × *T. monococcum*	479	13	2.7	46.1
1959	*T. monococcum* × amphidiploid	201	0	0.0	0.0
1964	amphidiploid × *T. durum*	528	3	0.6	33.3

Seed setting percentage was similarly low (6.3 per cent) when crossing *T. timopheevi* Zhuk. with the amphidiploid. The reciprocal crossing of this combination as well as crossings of the amphidiploid with *T. durum* Desf. (Solary I.) and *T. carthlicum* Nevski were totally unsuccessful. Some seed set was obtained in the combination amphidiploid × *T. monococcum* L.

Fertility conditions. In the various generations of selected types of the amphidiploid *T. aestivo-timopheevi* the percentage proportion of fertile pollens proved to be different (Table 2).

Fertility expressed in grain number per ear and grain number per spikelet of the individual types was also examined. Table 3 shows the mean value ($\bar{x}$), range of variation (s) and standard deviation ($s_{\bar{x}}$) of these characteristics. The highest mean value of the mentioned yield components was found in 1957 in types I and III. Types II, V and VII proved to be highly sterile. In the next year the average fertility of amphidiploid plants, — with the

Table 2

Pollen fertility data of the T. aestivo-timopheevi amphidiploid

Type	1957 fertile	1958 fertile	1959 fertile	1961 fertile
	percentage			
I	46.7	34.1	37.1	54.6
II	37.8	24.8	23.5	41.2
III	35.9	45.3	61.7	—
IV	24.7	30.7	26.8	—
V	48.2	27.6	35.9	58.7
VI	37.6	60.4	—	—
VII	24.3	24.7	32.4	—
VIII	26.8	—	—	—
IX	—	37.1	—	—
X	—	39.7	—	—
XI	—	35.4	—	—

only exception of type XI segregated in the F_3, — decreased probably due to unfavourable weather conditions (spring- and early summer drought).

In the subsequent generations fertility of various types of the amphidiploid gradually improved. Differences in fertility between the individual selected types were also observed. Ear productivity of some types (e.g. type V) was lower in early while higher in later generations. The opposite case also occurred, when the grain number per ear of plants belonging to types IV, X and XI was relatively high in the F_2 and F_3 and decreased in the subsequent generations.

Types I, II, and V — in which plants of relatively high productivity occurred more frequently — proved to be the most suitable for selection. It was from these types that we first succeeded in selecting plants producing more than 20 grains per ear in 1959. In 1961 plants producing an average of 31 grains per ear were already obtained.

Cytological examinations. We studied the chromosome coupling conditions of the segregated types of the *T. aestivo-timopheevi* amphidiploid. During the examinations a great number of plants with $2n = 56$ chromosomes were observed among those having a chromosome number of $2n = 70$. These sesquidiploids occurred primarily in the compactoid and squarehead types and only to a lower extent in the speltoid and other types. In reduction cell division the high frequency of univalents was remarkable, e.g., in 1959 in 96.3 per cent of the examined cells of plants with $2n = 56$ chromosomes non-coupling chromosomes were found. In 31.1 per cent of the cases two, in 35.6 per cent

Table 3

Fertility of the T. aestivo-timopheevi amphidiplodi

Year	Type	N	Grain number/ear			Grain number/spikelet		
			$\bar{x}$	s	$s_{\bar{x}}$	$\bar{x}$	s	$s_{\bar{x}}$
1956	F_1	22	6.7	2.1	0.7	0.4	1.3	0.5
1957	I	44	3.5	4.1	0.6	0.2	1.5	0.2
	II	3	0.2	0.7	0.4	0.0	0.0	0.0
	III	4	3.5	2.5	1.2	0.2	1.6	0.8
	IV	4	3.0	2.5	1.2	0.2	1.4	0.7
	V	1	0.4	—	—	0.0	—	—
	VI	3	1.5	2.8	1.6	0.1	0.7	0.4
	VII	6	0.1	4.2	1.7	0.0	2.2	0.9
	VIII	1	4.0	—	—	0.0	—	—
		66	1.6			0.1		
1958	I	103	1.0	1.5	0.2	0.1	1.1	0.1
	II	9	1.6	2.9	1.0	0.1	2.1	0.7
	III	19	0.5	1.0	0.2	0.0	0.8	0.2
	IV	5	1.0	1.6	0.7	0.1	1.1	0.5
	V	2	1.7	—	—	0.1	—	—
	VI	8	0.8	2.0	1.4	0.0	1.0	0.7
	VII	5	0.1	0.5	0.2	0.0	0.4	0.2
	VIII	10	0.2	0.7	0.1	0.0	0.6	0.1
	IX	4	0.2	0.6	0.3	0.0	0.6	0.3
	X	2	2.3	—	—	0.2	—	—
	XI	1	3.8	—	—	0.2	—	—
		168	1.2			0.1		
1959	I	162	5.6	11.8	3.1	0.3	0.5	0.1
	II	37	4.4	4.2	1.6	0.3	0.5	0.1
	III	10	3.9	3.9	1.5	0.3	0.4	0.1
	IV	9	0.9	2.0	1.4	0.1	0.7	0.4
	V	24	9.1	9.8	2.9	0.5	1.3	0.5
	VII	15	0.8	2.0	1.4	0.0	1.0	0.7
		257	4.5			0.3		
1961	I	163	11.5	12.0	0.9	0.7	1.9	0.6
	II	96	18.6	9.2	2.8	1.1	1.3	0.4
	V	51	4.7	2.1	0.7	0.5	2.3	0.8
		310	11.6			0.8		

Year	Type	N	Grain number/ear			Grain number/spikelet		
			$\bar{x}$	s	$s_{\bar{x}}$	$\bar{x}$	s	$s_{\bar{x}}$
1962	I	146	13.5	4.8	1.2	0.8	0.5	0.1
	II	8	10.1	6.3	0.9	0.6	0.4	0.1
	V	45	23.9	6.0	2.2	1.6	1.1	0.5
		199	15.8			1.0		
1963	I	212	15.5	2.2	0.2	1.0	2.6	1.4
	II	15	14.9	5.6	1.4	1.0	1.3	0.4
	V	31	17.3	2.4	0.4	1.0	1.8	0.6
		258	15.9			1.0		
1964	I	196	18.0	5.2	0.4	1.1	2.0	0.6
	II	35	13.8	4.6	2.1	0.8	0.4	0.2
	V	18	14.0	6.2	1.5	0.8	1.2	0.4
		249	15.2			0.9		

Table 4

Irregular reduction cell division in two types of the T. aestivo-timopheevi amphidiploid

Type	Number of cells examined	Chromosomes coupling %	Percentage frequency of univalents						Chromatin bridge %	Fragment %	Rings %
			2	4	5	6	8	Total			
III	220	3.7	31.1	35.6	—	17.2	12.4	96.3	3.8	4.2	2.9
VII	310	8.2	26.5	29.5	3.6	12.6	19.6	91.8	2.6	5.1	1.8

four, in 17.2 per cent six and in 12.4 per cent eight, ten and even more univalents were observed (Table 4). Apart from the cell division abnormalities mentioned, free chromosome coupling according to type, presence of rings consisting of 3—4 chromosomes, chromatin grains and bridges as well as uneven distribution of chromosomes between the two poles also occurred.

Qualitative characters. In the course of morphological examinations the intermediary character of F_1 plants was found to be maintained by majority in the subsequent generations also. The hairiness of leaf blades, culms, auricle and ligule in the first generation as well as in types segregating in the F_2 and F_4 generations was of intermediary character as compared to the glabrous variety F 481, on the one hand, and the conspicuously hairy *T. timopheevi* Zhuk. on the other. Similarly, the pink colour of the auricula (red with F 481 and

white with *T. timopheevi* Zhuk.) as well as the position, roughness and stiffness of leaves were also of intermediary character.

Due to the high number of diverse features in both parents the majority of the progenies was heterozygous. Types segregating in the F_2 and F_3 generations are characterized as follows:

Type I was generally intermediate with respect to the above mentioned morphological characters, and resembled *T. timopheevi* Zhuk. only in the ear compactness.

Type II had ears more like those of the parent variety F 481 in shape and compactness. Beards were short, undulating at the base.

Types III and IV were of squarehead character, spikelets moderately loose at the base, while closely set on the upper part; the latter type had wider and conspicuously hairy ears.

Type V had sharp tipped, front-wise flattened ears with nearly the same compactness as *T. timopheevi* Zhuk., though less hairy than usual in the species.

Types VI and VII included plants with extremely long and loose ears reminding *T. spelta* L.; all variations between short and long beards were found among them. In the latter type beards were found only on the upper part of the ears.

Type VIII included plants of compactoid character, with short beards. In the F_4 new segregating forms were observed, such as type IX, which had extremely narrow, rather loose ears with outstretched beards and hard, stiff glumes.

There were, further, plants belonging to type X with loose spikelets in the upper part and having highly elongated glumes at the lower third of the narrowed ears.

Finally, type XI was characterized by moderately compact parallel ears, glume shape reminding of *T. aestivum* L. and short beards.

All types dominantly inherited the fragility of the ears of *T. timopheevi* Zhuk. which are difficult to thresh. It is only from the ears of squarehead plants (III, IV) that grains are readily threshed.

Quantitative characteristics. When studying the quantitative characteristics we found great differences between the various types of the amphidiploid. Plants belonging to types VI and VII had the longest straw and ear as well as the highest number of spikelets per ear (Table 5). In all types mean value and variability of quantitative characteristics proved to be lower in the F_3 generation (1958) than in the F_2. In the subsequent generations — except for certain values — the averages of quantitative characteristics examined increased again (Table 6). The compactness of ears (D-value) is also characteristic of the type. Types V and — especially — VIII had the most compact ears. Plants similar to *T. spelta* L. had the lowest D-value.

Table 5

Trends of some quantitative characters of the T. aestivo-timopheevi amphidiploid

Year	Type	N	Plant height			Ear length			Spikelet/ear			Ears/plant			D value
			$\bar{x}$	s	$s_{\bar{x}}$	$\bar{x}$	s	$s_{\bar{x}}$	$\bar{x}$	s	$s_{\bar{x}}$	$\bar{x}$	s	$s_{\bar{x}}$	
1956	F_1	22	85,2	1.9	0.7	11.3	0.8	0.3	18.5	1.4	0.5	7.8	1.6	0.6	16.4
1957	I	44	117.9	1.2	0.2	10.3	1.2	0.2	18.4	1.3	0.2	13.9	1.2	0.2	17.8
	II	3	89.2	0.7	0.4	9.5	1.0	0.6	16.7	0.7	0.4	9.7	1.4	0.8	17.4
	III	4	102.9	2.4	1.2	8.5	0.8	0.4	16.3	1.3	0.7	9.3	1.3	0.7	19.2
	IV	4	100.0	1.2	0.6	11.0	0.8	0.4	18.0	1.3	0.6	10.5	1.2	0.6	16.4
	V	1	116.7	—	—	6.0	—	—	19.0	—	—	23.0	—	—	31.6
	VI	3	138.0	1.6	0.9	12.0	1.6	0.9	20.2	1.6	0.9	12,7	2.0	1.2	16.8
	VII	6	125.5	1.3	0.5	13.8	1.7	0.7	20.8	2.4	1.0	18.8	2.0	0.8	15.7
	VIII	1	117.0	—	—	5.0	—	—	19.0	—	—	23.0	—	—	38.0
			113.4			9.5			18.5			15.1			
1958	I	103	70.1	1.1	0.1	8.6	1.0	0.1	13.7	1.4	0.1	4.0	0.7	0.1	15.9
	II	9	70.0	1.5	0.5	9.7	1.1	0.4	13.1	1.3	0.4	3.6	0.5	0.2	13.5
	III	19	57.4	1.0	0.2	6.0	0.8	0.2	14.6	1.5	0.3	3.3	0.4	0.1	24.3
	IV	5	74.0	1.2	0.6	9.2	1.2	0.6	14.4	0.9	0.4	5.5	0.7	0.3	15.4
	V	2	73.8	—	—	6.2	—	—	15.5	—	—	7.5	—	—	25.5
	VI	8	90.0	1.0	0.7	11.0	1.0	0.7	18.0	3.0	2.1	12.5	2.0	1.4	16.4
	VII	5	75.0	2.2	1.0	12.0	1.6	0.7	14.2	1.9	0.8	4.5	0.7	0.3	11.9
	VIII	10	56.0	1.4	0.5	4.0	0.5	0.2	12.6	2.3	0.7	4.0	0.6	0.2	31.5
	IX	4	62.5	1.3	0.7	8.0	0.0	0.0	12.0	2.9	1.5	8.8	1.9	1.0	15.0
	X	2	70.0	—	—	9.0	—	—	14.0	—	—	2.5	—	—	15.5
	XI	1	83.0	—	—	9.0	—	—	16.0	—	—	5.0	—	—	17.7
			71.1			8.4			14.4			5.9			

Table 6

Trends of some quantitative characters of T. aestivo-timopheevi amphidiploid

Year	Type	N	Plant height			Ear length			Spikelet/ear			Ear/plant			D value
			$\bar{x}$	s	$s_{\bar{x}}$	$\bar{x}$	s	$s_{\bar{x}}$	$\bar{x}$	s	$s_{\bar{x}}$	$\bar{x}$	s	$s_{\bar{x}}$	
1959	I	162	—	—	—	8.8	1.0	0.4	17.8	1.5	0.6	—	—	—	20.2
	II	37	—	—	—	9.8	2.0	0.5	16.6	3.5	0.9	—	—	—	16.9
	III	10	—	—	—	8.1	2.1	0.5	16.1	2.4	0.7	—	—	—	19.9
	IV	9	—	—	—	11.1	1.2	0.4	18.2	3.0	2.1	—	—	—	16.4
	V	24	—	—	—	8.0	2.0	0.5	17.6	2.9	1.4	—	—	—	22.0
	VII	15	—	—	—	12.8	1.8	0.7	15.9	1.5	0.3	—	—	—	12.5
						9.9			17.0						
1961	I	163	98.9	12.3	1.0	12.7	1.2	1.0	18.5	3.6	0.3	7.6	43.2	3.4	14.6
	II	96	101.4	10.3	3.1	11.7	1.8	0.5	17.3	1.3	0.4	6.0	2.1	0.6	15.5
	V	51	94.0	21.8	6.9	7.2	3.7	1.2	15.3	2.2	0.7	4.3	2.0	0.2	21.3
			98.1			10.3			17.0			5.9			
1962	I	146	75.0	4.6	1.0	9.1	0.8	0.0	16.0	1.5	0.0	5.8	1.7	0.4	17.5
	II	8	83.7	1.6	0.6	10.0	0.5	0.2	15.5	1.1	0.2	6.7	2.1	0.8	15.5
	V	45	78.5	14.8	2.2	8.5	1.3	0.2	17.2	16.2	5.8	6.5	2.5	0.4	20.2
			79.1			9.2			16.2			6.3			
1963	I	212	69.9	10.1	0.7	9.9	1.0	0.1	15.1	1.0	0.1	4.1	3.6	0.3	15.2
	II	15	72.9	5.6	1.4	9.2	5.6	1.4	15.5	1.1	0.3	4.8	1.3	0.3	16.8
	V	31	76.2	5.3	0.9	8.5	1.5	0.3	17.2	1.3	0.2	4.1	1.6	0.3	20.2
			73.0			9.2			15.9			4.3			
1964	I	196	86.6	10.2	0.7	11.3	1.4	1.0	16.2	2.6	0.2	4.6	2.7	0.2	14.3
	II	35	87.0	13.0	5.9	11.9	1.5	0.7	16.5	1.2	0.5	2.0	2.3	1.1	13.8
	V	18	85.0	8.5	3.9	10.4	1.4	0.3	17.6	1.6	0.4	2.2	0.8	0.2	16.9
			86.2			11.2			16.8			2.9			

Most of the types, especially type V, were resistant to leaf and stem rust. The segregated types proved to be resistant to powdery mildew as well. Since plants selected from the amphidiploids are not directly suitable for commercial production, we endeavour to develop adequate strains by producing a high number of various combinations.

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REFERENCES

Becker, C. (1954): Problematik der Pflanzenzüchtung. Deutsche Akademie der Landwirtschaft, Berlin.

Carenja, M. P.—Nikolskij, Ju. K. — Цареня, М. П. — Николский, Ю. К. (1966): Характеристика мейоза у амфидиплоидных форм пшениц. Докл. Акад. Наук БССР, Минск, **II,** 905—908.

Győrffy, B. (1939): Colchicinnel indukált polyploidia. I. (Polyploidy induced with colchicine. I). Acta Biologica, **5,** 1—29.

Müntzing, A. — Мюнцинг, А. (1955): Искусственная полиплоидия зерновых культур. Шфалевская селекционная станция (Швеция) 1886—1946. Изд. Иностр. Лит, Москва.

Oehler, E. (1938): Die Ausnützung von Art- und Gattungsbastarden in der Weizenzüchtung. Züchter, **6,** 205—211.

Sears, E. R. (1941): Amphidiploids in the sevenchromosome Triticinae. Missouri Agric. Exp. Sta. Res. Bull., 336.

Stebbins, G. L. (1947): Types of polyploids: their classification and significance. Adv. Genet., **1,** 403—429.

Zsebrak, A. P.—Жебрак, А. П. (1944): Синтез новых видов пшеницы. Сельск. Акад.. **6,** 1—54.

Zsebrak, A. P.—Жебрак, А. П. (1957): Полиплоидные виды пшениц. А. Н. СССР, Москва, 123.

Zsebrak, A. P.—Nikolskij, Ju. K.—Mankevits, O. I.—Жебрак, А. П. — Николский, Ю. К. — Манкевич, О. И. (1964): Скрещивание форм, выделенных при расчеплении 70-хромосомного амфидиплоида, с исходным видом мягкой пшеницы. Вопросы Генетики и Селекции, Минск, Изд. Наука и Техника, 116—122.

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EXAMINATION OF THE TECHNOLOGY OF ALFALFA DRIED WITH HOT AIR REGARDING THE CONSERVATION AND STABILIZATION OF CAROTENE

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The experiments carried out for the sake of the reduction of the first cost of alfalfa dried with hot air have proved to be efficacious.

It is advisable to dry the green alfalfa in the meadow down to 68—70 per cent water content after mowing because in this way 15 kg of fuel-oil can be economized after each two-hundred weight of alfalfa hay. At the same time the loss of protein and carotene is very little.

The result of the experiments concerning carotene stabilization proved that in the interest of the reduction of carotene losses it is most practical to treat the material immediately after drying with an antioxidant and to briquet it after with suitable presses. Nevertheless it is — in the case of briqueting — superfluous to grind the material after drying. It is enough to briquet the small, chopped, dried material. In this case the specific gravity of the final product increases in a high degree, less storage will be necessary, the transport will be easier and the carotene content can be preserved with little loss for a long time.

The costs of production can also be reduced with a proper regulation of water withdrawal. It is sufficient to dry the green alfalfa to a dry material content of 88—90 per cent.

Introduction

The green alfalfa conserved with hot air and alfalfa meal produced from it was well as the making of briquet have meant a great step in the field of the improvement of the protein and carotene economy, because hereby the great protein and carotene content of our most valuable roughage can be saved with essentially lower losses. The technology of conservation is, however, very expensive and as the production costs of our agricultural products are very high on behalf of profitable production the reduction of the former should be kept in mind.

For this reason the aim of our work has been directed towards reducing the prime costs of this product made in steadily increasing quantity, and doing all this by the improvement and suitable modification of technology maybe by the appropriate simplification of the process.

We have tried to obtain our aim as follows: First of all there was examined the green alfalfa put in the drying apparatus not immediately after mowing but after having made use of the natural drying effect of solar energy as well. Then prewithered for a time it was transported to the farm and examined how the quantity of the fuel-oil used up for drying could be decreased.

As the loss of nutrients and active ingredients by natural drying is very high, the duration of the prewithering time had to be tested as to obtain the final product without essential loss of nutrients and active ingredients and, on the other hand, the loss observed had to be compared to the value of the economized fuel-oil.

Secondly we endeavoured to reduce the losses of one of the most important active ingredients of the alfalfa, the carotene. According to our previous experimental data these losses were extremely great during the drying period. By our process we have meant to stabilize the carotene level, as the higher carotene level is of great importance in animal husbandry not only from physiological point of view, but it may enable us also to diminish the costs of production.

Finally and to avoid unnecessary trade expenses we wished to examine the measure of the reasonable dry material percentage obtained through drying.

The first foreign literary data concerning feed-drying with hot air were published during the interwar period. Col. Politt gave an account of his drying experiments carried out in 1935, in England. Bondry wrote about the systems and technology of the different dryers. DIJKSTRA (1957) analysed the digestible crude protein losses during hot air drying and according to his experimental data this was about 15 per cent while SHEPERD—WIESEMAN (1954) observed losses about 8.2 per cent. BOSH—SEIP (1940) published data mainly about carotene losses in alfalfa hay which may be ascribed — in their opinion — to the activity of microorganisms and fermentative effects at high storage-temperatures. DOLGE—DEMBICZAK—ROUSSEAU—EATON (1955) determined the carotene losses dependent on different circumstances between 0.17—6.80 mg/lb. Mrs. DÖRNER (1955) reported the following data for carotene losses after mowing on the basis of exact measurings:

6 hours after mowing	16—18 per cent
24 hours after mowing	23—33 per cent
96 hours after mowing	88—95 per cent

The above-mentioned data refer to normal weather at swath-drying. In rainy weather the losses may redouble. We got similar results in our own experiments. According to LENKEIT (1954) the carotene content of freshly mown red clover was 276 mg, while 24 hours later he found 219 mg. This corresponds to 21 percentage loss and agrees with the data of Mrs. DÖRNER. According to SHEPERD—WIESEMAN (1954) the carotene losses are during conservation especially high and these losses are better increased by the prolonged conservation than by the conservation method.

On the basis of several hundred analyses performed under Hungarian conditions KUNFFY (1962, 1963) stated that depending on the mode of drying

the high carotene content of the green material had been spoiled under the influence of light, heat and air

The mode of storage, however, has also a great influence on the increase of carotene losses after drying.

In literature there are great differences in data regarding carotene contents but in all probability this originates less from the inaccuracy of the experimental methods than more from the fact that the roughage of the same sort

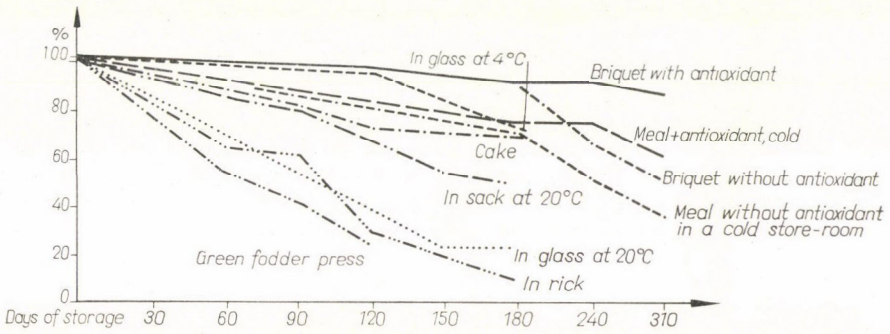

Fig. 1. The changing of carotene content at the adoption of different storage methods

produced on the very same land but in different years had a variable carotene content. This variability is very likely due to the changes of weather which has a considerable effect on the carotene formation.

In Hungarian literature TANGL (1954, 1955) and KUNFFY (1955, 1962, 1963) have dealt with the problems of carotene losses not only for the determination of numerical values of losses but also for the reduction of losses.

Material and Method

After having examined the products of hot air dryers operating in several state farms (Mezőhegyes, Hortobágy, Hajduszovát, Palotás, Dalmand etc.) our experiments were, from 1962, focussed on the farms of Palotás and Hajduszovát.

Prewithering experiments were above all conducted in such a way that part of the green alfalfa mowed, at a definite time was transported to the dryer, immediately after mowing. The other part was divided into two parts. In the first experiment the alfalfa was prewithered on carpet-swath and transported 4 and 6.5 hours later to the farm. In the second experiment 3 and 6 hours later was the prewithered alfalfa transported to the dryer. In every case we took average samples from both the green and dried material freshly and in every stage of the prewithering in order to examine the content of nutrients and carotene.

As we could not accomplish the chemical analyses on the spot except the determination of dry material — the samples of green alfalfa were chopped to small pieces and put for conservation into methanol or a solution of 10 per cent KOH diluted in alcohol of 96 per cent. The dry product was transported in polyethylene bags to our laboratory in Budapest where the analyses were carried out. The samples of green alfalfa were also gathered in polyethylene bags for nutrient determinations. All samples were measured on the spot and kept

in a cool place then in refrigerators until the time of the test. The following day of our return we began the examination of the samples.

The determination of the nutrient-content was carried out according to the prescriptions of Hungarian Standard No. 6831—56. In the carotene determinations we adopted the method developed by Mrs. DÖRNER, simplified in our Institute by Mrs. JAKABFFY and accepted by the Council For Mutual Economic Help.

We scuffed the measured green material with quartzsand, chromatographed it on an activated aluminium-oxide column. Afterwards the value of the petroleum ether solution was measured on the S—47 colourfilter of the Pulfrich-photometer.

The material measured off from the dry meal, after being scuffed with quartzsand and mixed with a bit of petroleum ether was held in a water-bath of 40°C, for 10 minutes, then chromatographed in the same way and its value measured.

The experiments for the stabilization of carotene content were carried out as follows: Samples of 1 kg each of ready-made product dried with hot air and stored in marked sacks in the farm were stored in our laboratory in different ways; in polyethylene sacks and paper sacks consisting of three layers, in a dry and cool place at laboratory temperature in stoppered brown powder bottles at normal room temperature and in a refrigerator at 4°C. We examined the samples stored in the farm parallel with those stored at the Institute. The materials were sprinkled with different antioxidants and their carotene content examined about every 2 months.

Later on experiments on a large scale were carried out also in the drying mills with the use of antioxidants.

In order to get the material better mixed and thus to reach a better efficiency made fecula and then oil was added to the mixture in a little mixing machine. In the farm of Hajduszovát the results of the antioxidant-treatment introduced in the large scale practice were also examined.

The other part of the material was briqueted in the experimental farm of Iregszemcse with an old oil-cake-press producing cakes of 20—22 cm diameter and 6—8 cm thickness. After the import of the English and German made briquet-presses the products produced on these presses were examined monthly. Among these the California Hyflo Press type 50 HP manufactured by the British firm Simon Ltd. Stokport proved to be the best. Part of the products to be pressed was also treated with antioxidant as we wanted to study the effect of the combined treatment. To point out whether the antioxidant mixed to the food has a deleterious effect on the organism of animals experiments were carried out on rats with the feeding of foods treated with antioxidants. All these experiments gave negative results.

Finally we dealt with the question whether the generally used rate of dehydration 92—95 per cent dry material content) being—in our opinion—too high, is right at all and what rate would be the most advisable from economical point of view.

Results

A) *Prewithering experiments.* We carried out these experiments for several years because of the yearly changes of the climatic factors. Their results are summarized in Table 1. It becomes evident from the data of Table 1 that there are no substantial protein losses in the green alfalfa prewithered until reaching a water-content of 68—70 per cent and the carotene losses are also not excessively high. Consequently it is advisable to prewither the green alfalfa until it has reached the above-mentioned water-content as the economical calculations disclose also essential savings in working costs. However, one must not exceed the above-mentioned degree of prewithering because the value of the final product deteriorates visibly, first of all its carotene content, though the protein content does not diminish considerably in the case of a slightly more increased water-content. Therefore, in such cases as the greatest importance is attached to the carotene content of the final

Table 1

Prewithering experiments

Period of prewithering	Green alfalfa			Dried alfalfa	
	Dry material %	Dig. crude protein %	Carotene mg/kg	Dig. crude protein %	Carotene mg/kg
	converted into absolute dry material				
1. freshly	23.0	23.5 = 100	240 = 100	21.9 = 100	122 = 100
after 3 hours	28.0	21.4 = 91	200 = 83	20.7 = 94	119 = 98
after 6 hours	33.5	21.2 = 90	168 = 70	20.7 = 94	111 = 91
2. freshly	25.0	22.6 = 100	280 = 100	21.2 = 100	284 = 100
after 3 hours	30.0	21.0 = 93	240 = 86	20.0 = 94	232 = 93
after 6.5 hours	35.0	20.7 = 92	200 = 72	19.6 = 93	200 = 91

product, such as e.g. at the starters for poultry, it is not reasonable to prolong the above-mentioned prewithering period. If the protein and not the carotene content of the material is mainly important as e.g. at the cattle, we can go as far as 66—68 per cent water-content. But this is the extreme limit which does not endanger the greater advantage attainable with hot-air-drying, i.e. the low protein and carotene losses.

Our experimental findings described above have been accepted by the state farms and on the basis of these their hot-air-drying shops were ordered to prewither the green alfalfa to 70 per cent of the water-content. Thus the results of our experiment are already accepted on large scale farming.

B) *Stabilization of carotene content.* The second aim of our work was to preserve — until the consumption of forage — its carotene content that had still remained after drying. Our earlier investigations have already proved that exhausting the air from the dried material the decomposition of carotene can be considerably reduced and so, its carotene content preserved for a long time. Experimenting with an old oil-cake-press, 70 per cent of the carotene content measured at drying was still detectable after 180 days. These briquets had been used up also at the Artificial Insemination Station, Budapest, in the comparative experiments carried out on 20 bulls in 4747 inseminations. The quality of the bull-sperm of the animals consuming these briquets improved (greater density of the sperm, more living spermia in the sperm, etc.) and at the same time the number of pregnancies increased by 3—4 per cent. The improvement of the biological value of the sperm was determinable not only during the period of briqueting but within the following 30 days, too.

Later on we employed the German green-food-press (Grünfutterpresse) in similar experiments. The results of these were negative. The carotene

produced with these presses decreased, after 120 days, to 30 per cent of the original content, thus they did not answer the purpose at all.

The third series of our experiments has been carried out with the testing and comparing of antioxidants. We put in serial experiments with ethoxy-methyl-quinolin, butyl-hydroxy-toluol, norhydro-oleic-acid, adapting a concentration of 0.015 and 0.030 per cent. Further, we tried the dried carbonic acid, too, in concentrations of 1.0, 5.0 and 10.0 per cent. The latter was placed at the bottom of polyethylene sacks, then alfalfa meal poured over it and the sacks tightly bound.

The mode of use of antioxidants has already been described above.

On the basis of a series of experiments we stated that the carotene content of the material stored in the paper sacks had deteriorated in a slightly greater degree than in the polyethylene sacks. Among the antioxidants the ethoxy-methyl-quinolin had proved to be the most efficient.

In one experiment it struck us that in winter the carotene content of the alfalfa meal stored in sacks at a cool place in the barn was considerably higher than the one stored in stoppered brown powder bottles at laboratory temperature. Therefore we put in comparative experiments. In this investigation of several months the alfalfa meal was being uniformly kept in stoppered brown powder bottles, some at laboratory temperature of 20°C while the others in refrigerators at 4°C.

Stored at 20°C	29 per cent
stored at 4°C	72 per cent carotene

remained in the alfalfa meal.

This fact has clearly proved that in cool environment without light, air and any treatment, the carotene content of the alfalfa meal can be satisfactorily preserved.

In the following experiments the English Simon presses were also put in. In these investigations we compared the alfalfa meal and briquet with and without antioxidants. We stored the briquets alla rinfusa and the meal samples in sheet iron boxes. The results are summarized in Table 2.

It is evident from Table 2 that with adequate briqueting equipments the stabilizations of carotene can be far better secured as if stored in the form of meal. Moreover the briqueting in itself without antioxidant gives also better results than if treated with an antioxidant. But if we use antioxidant before briqueting the result will be even better and most satisfactory in respect of feeding, too, as 310 days after drying, 87 per cent of the carotene content remained in the material.

Seeing that recently food mixing factories have — wrongly — disregarded the carotene content of dry alfalfa products when taking them over (which is opposed to foreign usage) but they have been paying off transported goods

Table 2

Stabilization of the carotene content

The period of storage	mg/kg carotene content in percentage of the final product			
	briqueted		meal	
	with antioxidant	without antioxidant	with antioxidant	without antioxidant
Produced in May	240=100	240=100	240=100	240=100
After 180 days (November)	220= 91.5	180= 75	210= 90.5	171= 71
After 240 days (January)	220= 91.5	180= 75	160= 67	125= 52
After 310 days (April)	210= 87	150= 62.5	125= 52	90= 38

on the basis of protein content provided they have also a minimum carotene content, the drying shops are — of course — reluctant to bear the unnecessary costs of antioxidant treatment and briqueting.

C) *The reasonable limit of dry material percentage at drying.* Finally we have tried to find out that up to what percentage of the dry material shops drying with hot air are advised to dry alfalfa, because the method of drying up to 92—95 per cent of the dry material content (a method followed by most of shops) seems quite superfluous, since at a water content of less than 12 per cent the equilibrium is restored by the vapour content of air. During storage period the alfalfa meal absorbes back so much humidity from the air that its water-content reaches 12 per cent. In case of 70 per cent water-content at the green alfalfa the cost of superfluous dehydration, on the average of 4—5 per cent is as follows:

to produce 100 kg meal of 88 per cent dry material content we need *293 kg*

to produce 100 kg meal of 93 per cent dry material content we need *310 kg*

green alfalfa. In the first case 193 kg, in the second 210 kg water must be evaporated. The difference is 17 kg, the evaporation of which needs approximately 2 kg of fuel-oil. The value of this represents 2.5 per cent of the cost of production. This can be economized so much the more as the drying of the weight unit can be accomplished within 5 per cent less time which at the same time means the proportionate increase of the output.

D) *Results of experiments from economical point of view.* It is very important to state with economic calculations in what degree the above-mentioned methods act on the reduction of the operating expenses because there are already progressive minded co-operatives in Hungary which want to put in such equipments on the basis of association. In the following calculation we compare the adequate physiological value of a synthetic vitamin A product with the alfalfa carotene though the latter has a significantly higher value of physiological influence than the synthetic product.

One cannot fail to emphasize that the import of the synthetic vitamin A means an outlay of currency against the alfalfa-carotene produced in Hungary without extra cost, where the carotene content needs nothing else than preservation.

The cost of antioxidant treatment is 4.6 per cent of the production cost including the surplus power and labour costs, running with this work. On the other hand on the basis of the "international vitamin A unit" of the product produced synthetically and put into circulation, the surplus value is 8.6 per cent, considering that the carotene content of alfalfa meal can be preserved approximately 6 months longer. Therefore, the net savings are 8.6—4.6= = 4.0 per cent of the production costs.

Continuing to develop the preservation of carotene by briqueting the meal, its expenses will be somewhat lower than the value of sacks for storage as well as the value of electric current used up to alfalfa meal production which requires a more increased drying. When preparing briqueting, alfalfa must not be dried to such an extent than at the production of alfalfa meal. If we take into account that at briquet making dried meal needs no previous grinding then one can discount the 96 kilowatt/hour current consumption of grinding machines which referred to the production cost represents an approximately 2.2 per cent additional saving. One can further mention that the specific gravity of the briquet is 2—4 times greater than that of the meal, hence its cost of storage is less and the same case is with the storeroom requirement.

As to the economy of prewithering, a water-content of 68—70 per cent (instead of 78—80 per cent) means minus 147 kg water evaporated it counting to 100 kg meal. This amounts to 15 kg fuel-oil, viz. Ft. 33 reduction of the expenses of production per two hundredweight of meal and at the same time it increases the output of the shop. As the evaporative capacity of the drying shop is 3000 l/hour at a water-content of 78—80 per cent, the output is only hardly 20 hundredweight in one hour.

Finally by the way of the proper adjusting of the reasonable degree of drying, the above-mentioned drying carried out to a dry material content of 88—90 per cent instead of 92—94 per cent the reduction of evaporation will be about 17 liter of water. This reduces the production costs of the alfalfa meal by 2.5 per cent. The above results introduced into practice on a large scale may lead as compared to the present production costs in case of normal efficiency of drying shops, to the following savings (250 watt in a year):

introduction of a suitable prewithering method	19.5 per cent
reasonable regulation of the degree of drying	2.5 per cent
correct accomplishment of the carotene stabilization	4.2 per cent
Total	26.2 per cent

From the above-mentioned and introduced methods only the first was put into practice in the large scale practice. The second one was started but given up later. The third one has not yet been solved though accepted theoretically because of wage-system and premium difficulties.

REFERENCES

BICKOFF, E. M.—THOMPSON, C. R.—LIVINGSTON, A. L. (1955): Alfalfa carotene effect of added animal fats and vegetable oils on stability carotene in dehydrated alfalfa meal. Jour. of Agr. and Food Chem., **3,** 67—69.

BRATZLER, J. W.—KECK, K.—YOERGER, R. R. (1960): Effect of temperature upon the nutritive value of artificially dried hay. Jour. of Anim. Sci., **19,** 1186—1190.

BROWNING, B. C. (1960): Comparison of food-briquet, baled and granulated hay. Agr. Lead. Dig. Chicago, 9.

BUCKINGHAM, F. (1961): Is the production of food-cake profitable? Tract. Kansas City, 6.

DIJKSTRA, N. D. (1957): The conservation of grass for feeding purposes in agriculture. State Agr. Exp. Station, Hoorn.

DIJKSTRA, N. D. (1949): Verteerbaarheid en voederwaarde van kunstmatig gedoogd gras. Min. van Landbouw. s, Gravenhage.

DOLGE, K. L.—DEMBICZAK, C. M.—ROUSSEAU, J. E.—EATON, H. D. (1955): Rate of loss of carotenoids from artificially dehydrated alfalfa under farm storage. Stor. Agr. Exp. Station Univ. of Connecticut, Stors, Con. Bull. 314.

DOBIE, J. B. (1960): The production of hay-briquet. Horard Dairman Fort Atkinson, 22.

DOBIE, J. B.—PARKS, P. B. (1956): Barn mow hay drying for better quality. California Agr. Exp. Sta. Univ. of California Circ, **454,** 3—19.

DOBIE, J. B. (1949): Barn mow hay drying in California. California Agr. Ext. Serv. Univ. of California. Circ., **149,** 3—16.

DÖRNER, L. (1955): Különböző eljárásokkal készült lucernaszénák szárítása közben fellépő változások (Changes during the drying of alfalfa hays produced by different methods). Állattenyésztés, **4,** 2.

KUNFFY, Z. (1955): The economical usage of foods in farming. Acta Agronomica Acad. Sci. Hung., **6,** 327—360.

KUNFFY, Z. (1962): Pillangós szálastakarmányok különböző betakarítási és tárolási módjainak vizsgálata és azok eredményei (Test and results of the different modes of harvesting and storage of Papilionaceous roughages). Állattenyésztés, **11,** 337—347.

KUNFFY, Z. (1963): Obecny stan konservajcni pasz objetsciowych i stabilizajci katotenu. NOT. Warszawa.

KUNFFY, Z. (1967): Forró levegővel tartósított lucerna felhasználása tehenek pótabrakjában (Using of alfalfa hay, dried with hot air in the supplemental fodder of dairy cows). Gazdálkodás, **11,** 47—50.

LENKEIT, W. (1954): Die Bedeutung der künstlich getrockneten Futtermittel in der Leistungsfütterung. Archiv Eid., **101,** DLG. ff.

LENKEIT, W. (1953): Einführung in die Ernährungsphysiologie der Haustiere. F. Enke Verlag, Stuttgart.

SCHNETZER, H. L. (1955): Über die Beständigkeit des Karotins in frischem und künstlich getrocknetem Gras. Mitt. aus dem Gebiet d. Lebensmitteluntersuchung und Hygiene. Eidg. Gesundheitsamt, **46,** 92—96.

SHEPERD, S. D.—WIESEMAN, H. G.—ELY, R. E. (1954): Experiments in harvesting and preserving alfalfa for dairy cattle feed. Techn. Bull., **1079,** 1—147.

TANGL, H. (1955): Vitamine, Hormone und Wirkstoffe in der Fütterung beim Rind. Wissenschaftliche Tagung für Tierernährung, Berlin.

THOMPSON, C. R.—BICKOFF, E. M.—LIVINGSTON, A. L. (1960): Carotene stability in alfalfa as affected by laboratory and industrial-scale processing. Agr. Res. Serv., 1232.

Acta Agronomica Academiae Scientiarum Hungaricae, Tomus 19 (1—2), pp. 147—160 (1970)

EXPERIMENTS WITH UNTHINNED POPPY CULTURES GROWN FROM IRRADIATED SEED MIXTURES

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By using partly irradiated seed mixtures in small plot and large-scale experiments a reliable germination has been achieved in 4 years. With an intact seed lot of 40 dkg/cad. hold* sown the stand was complete. Plants could be evenly thinned out to a distance of 10 cm, even when a labour force lower by an average of 50 per cent than the usual was employed. Plants grown from irradiated seed mixtures — having a better spacing from the beginning — showed better development. They produced a quantity of capsules and seeds equal to those of plants grown with the present technology. The small plot experiments proved that by sowing 30—40 dkg/cad. hold intact seeds (300,000—600,000 seedlings/cad. hold) a yield equal to that of thinned cultures could be obtained without thinning.

Introduction

The poppy, this important food- and pharmaceutical plant is grown on 0.3 per cent (about 25,000 cad. hold) of the total arable land in Hungary. The majority of production costs is given by the operations of thinning. This operation is expensive (700—800 Forint/cad. hold) as it can be successfully performed only by hand. In large-scale production one of the main targets is to decrease — as far as possible — manpower, since it is year by year less available, further, it is the most efficient way of reducing production costs. For the above reasons the thinning of poppies has long been tried to carry out with machines or facilitate by different methods. These mechanical solutions, however, have not yielded any satisfactory results so far.

When trying to determine radiation doses providing a genetic effect in breeding medical and essential oil plants, we have obtained results suggesting that, after having been treated with a dosis near the lethal level, seeds still germinated, but their meristems had been injured to such an extent that they could not further develop. They remained at the cotyledon stage and after showing typical symptoms of radiation disease for 2—3 weeks, they died. This observation has offered the basis for elaborating the method of growing poppies by using irradiated seed mixtures.

* 1 cad. hold (kh) = 0.57 ha.

Materials and Methods

We started small plot experiments in 1964 in the Central Field Station of the Institute at Budakalász. Preparatory experiments were being carried out for two years and observations were subsequently confirmed in systematic small plot experiments as well as on a large scale. In 1966, at Budakalász on an area of 0.5 cad. hold, and in two other farms (State Farm of Nagymiskolc and Co-operative Farm of Dunaegyháza) on 1 cad. hold each medium-scale experiments were carried out. To prove the results obtained in the previous years, in 1967 system-

Fig. 1. Poppy seedlings: below: grown from intact seeds, two weeks or so after coming out. Above: grown from irradiated seeds, about two weeks after coming out

atic small plot experiments were started on plots of 120 m^2 and 15 m^2 respectively, with 7 treatments in 5 replications, in our experimental stations of Budakalász and Darányipuszta.

Among the small plot poppy experiments we discuss in detail the one carried out at Budakalász in 1967 (Fig. 1). Seeds of the variety "Hatvani" were sown with a "Saxonia"-type automatic sowing machine on 6th and 8th March respectively at a row distance of 36 cm, and plants were thinned out to a distance of 10 cm on 8th and 11th April respectively. The experiment was free from weeds; harvesting took place on 9th July. Simultaneously with the systematic small plot experiments large-scale experiments were carried out in farms listed in Table 6.

Results

On the basis of the experiment the following observations were made and results obtained:

In seed-mixtures, irradiated seeds and untreated ones do not separate when sown with the usual sowing machines. Treated seeds germinate at the same time and practically with the same intensity and density as intact, untreated seeds.

Plants grown from irradiated seeds show — 10—15 days after emerging — the typical symptoms of radiation disease and they will have already been killed by the time when intact plants have 2—4 leaves (Fig. 2). Plants grown from intact, untreated seeds show no injury.

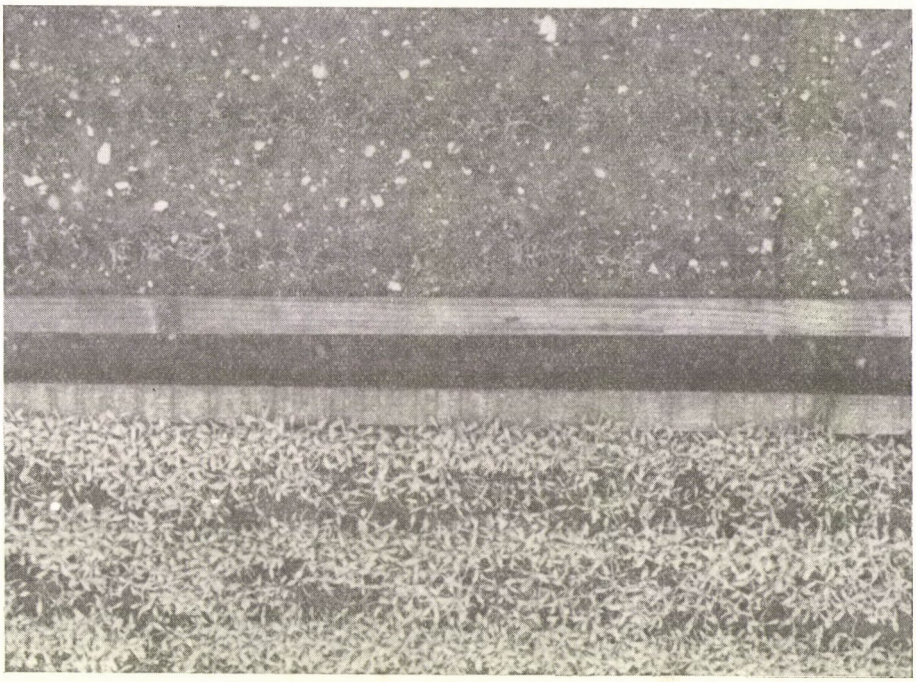

Fig. 2. Details from small plot experiments at Budakalász. In front: poppies thinned out late; behind: unthinned poppies grown from irradiated seed-mixture

In 1966, in the experimental field of Budakalász data of thinned plants and unthinned ones respectively were recorded at harvesting time. Mean values are shown in Table 1. According to the data of the table, in that part of the poppy field where the plants had been thinned out, the distribution of plants was more even than in the other part where irradiated seeds had been sown. Number of plants per meter was higher with the treated plants. As for the yield, this factor was not compensated either by the higher number or the larger weight of capsules of thinned plants. Distribution of plants and its evenness in the function of different quantities of seed in the systematic small plot experiments of 1967 are shown in Table 2. Taking the extreme values into consideration we can see that complete stands are obtained only with 40 dkg/cad. hold or more intact seeds sown.

Table 3 contains the developmental data of plants. Plants grown from

Table 1

Data on plant distribution and yield in the poppy experiment
Budakalász, 1966

Description	Unit	Thinned	Unthinned
Average number of plants per 1 meter at harvesting time	plant	7.70	24.60
Extreme values	plant	5—10	14—40
Average number of capsules per plant	capsule	2.30	1.60
Extreme values	capsule	1—4	1—3
Weight of capsules per plant	dkg	0.25	0.19
Weight of seeds per plant	dkg	0.31	0.25
Weight of yield per plant	dkg	0.56	0.44
Proportion of capsules compared to the total yield	%	44.60	43.20
Weight of capsules*	q/cad. hold	3.10	7.50
Weight of seeds*	q/cad. hold	3.80	9.80
Weight of yield*	q/cad. hold	6.90	17.30

* Converted into cad. hold on the basis of the number of plants per meter and the weight of capsules, seeds and yield respectively per plant!

Table 2

Distribution of plants 5 weeks after coming out, in the unthinned poppy experiment
Budakalász, 1967

Treatments	Average number of plants per metre	Extreme values	Average distance of plants (cm)	Extreme values
20 dkg intact seed	20.2	1— 35	4.9	1—57
30 dkg intact seed	27.8	7— 48	3.6	1—35
40 dkg intact seed	37.6	20— 64	2.6	1—16
50 dkg intact seed	44.3	25— 68	2.2	1—20
60 dkg intact seed	55.0	30— 74	1.8	1—17
200 dkg intact seed	250.0	200—300	0.4	1— 5

irradiated seed-mixtures showed a better development than those thinned out in time. Treated plants had also a higher number of well developed capsules — except for those grown from 20—30 dkg intact seeds sown per cad. hold. As for the total number of capsules — in accordance with observations made in the previous year — plants thinned out in due time were the best again, since plants thinned to a distance of 10 cm had many undeveloped capsules. Late thinning had an unfavourable effect on the growth and development of plants.

Table 3

Developmental data of poppy plants in the thinning free experiment
Budakalász, 1967

Treatments	Average height (cm)		Number of capsules		
	at spearing	at flowering	on 100 plants		Total
			over 5 g	under 5 g	
20 dkg/cad. hold intact seed	7.10	66.8	32.4	114.8	147.2
30 dkg/cad. hold intact seed	7.30	66.5	57.4	103.2	160.6
40 dkg/cad. hold intact seed	8.34	71.9	72.0	101.6	173.6
50 dkg/cad. hold intact seed	8.06	67.9	74.0	98.4	172.4
60 dkg/cad. hold intact seed	8.00	60.0	63.0	95.2	158.2
Control I.					
200 dkg/cad. hold intact seed (thinned IV. 28)	7.40	58.0	58.00	150.4	208.4
Control II.					
200 dkg/cad. hold intact seed (thinned V. 11)	6.08	35.3	16.8	96.0	112.8
SD 5%	—	6.7	4.1	5.2	17.8

Table 4 and Fig. 3 present the yields. Plants grown from irradiated seed-mixtures produced — even without thinning — the same yield as those thinned out in time, except again for the treatment with 20—30 dkg/cad. hold seeds sown. Late thinning caused a disaster concerning the yield — especially in the experiment at Budakalász — owing to the drought (between June 10 and July 13 mean temperature in the daytime was an average of 16—33°C; during this period on 12 occasions a total of 40 mm rain fell only). That is why capsule percentage increased to 60—70 per cent from the usual 50 per cent.

On the above basis, theoretically calculated amount of intact seeds — 10—15 dkg/cad. hold mixed with 185—190 dkg irradiated seeds — does not provide a complete stand due to an imperfect equalization and uneven sowing.

With the present technical equipment — concretor, "Saxonia" sowing machine — an amount of 30—40 dkg untreated, intact seeds are needed in a seed-mixture of 2 kg/cad. hold to ensure an even stand. With equalization improved and seeds sown more evenly this amount is gradually decreasing and nearing the theoretical level.

Crop results of medium-scale tests performed in the State Farm of Nagymiskolc and the Co-operative Farm of Dunaegyháza in 1966 corresponded to the average poppy yield of the farm and this method of growing was made known to the experts of the farm. On the basis of experiences obtained in the previous years, in 1967 large-scale tests were performed in state farms and co-

Table 4

Trend of yields in small plot
Budakalász,

Treatments	Yield			
	On a plot (kg)			
	Seed	Capsule	Total	Capsule percentage
Without thinning				
200 g intact seed	0.83	1.69	2.52	67.1
300 g intact seed	1.67	3.97	5.64	70.4
400 g intact seed	4.10	6.20	10.30	60.2
500 g intact seed	3.31	6.93	10.24	67.7
600 g intact seed	3.95	6.69	10.64	62.8
Thinned out in time				
2000 g intact seed	2.79	6.16	8.95	68.8
Thinned out late				
2000 g intact seed	0.02	0.03	0.05	60.0
Sd 5%	1.21	3.00	3.02	

Table 5

Trend of yields in small plot
Daránypuszta,

Treatments	Yield			
	On a plot (kg)			
	Seed	Capsule	Total	Capsule %
Without thinning				
200 g intact seed	0.97	0.80	1.77	45.2
300 g intact seed	1.12	0.99	2.11	46.7
400 g intact seed	0.91	0.94	1.85	50.6
500 g intact seed	1.24	1.02	2.26	45.1
600 g intact seed	1.20	1.07	2.27	47.1
Thinned out in time				
2000 g intact seed	0.92	1.08	2.00	54.0
Thinned out late				
2000 g intact seed	0.56	0.51	1.07	48.3
Sd 5%	0.37	0.39	0.62	

experiments with unthinned poppies
1967

On a cad. hold (kg)			Seed production compared to the control (kg)				Proportional number of seed production %
			plot		cad. hold		
Seed	Capsule	Total	+	−	+	−	
39.8	81.0	120.8		1.96		94.0	29.7
80.1	190.4	270.5		1.12		53.7	59.8
196.6	297.3	494.9	1.31		62.8		146.9
158.7	332.3	491.0	0.52		24.9		118.6
189.4	320.8	510.2	1.16		55.6		141.5
133.8	295.4	429.2	—	—	—	—	100.0
1.4	2.4	3.8		2.77		132.4	1.0
58.3	143.87	144.83	—	—	—	—	—

experiments with unthinned poppies
1967

On a cad. hold (kg)			Seed production compared to the control (kg)				Proportional number of seed production %
			plot		cad. hold		
Seed	Capsule	Total	+	−	+	−	
372.2	306.9	679.1	0.05		19.2		105.4
429.7	379.8	809.5	0.20		76.7		121.7
349.1	360.6	709.7		0.01		3.9	98.9
475.7	391.3	867.0	0.32		122.7		134.7
460.4	410.5	870.9	0.28		107.4		130.4
353.0	414.4	767.4	—	—	—	—	100.0
214.8	195.7	410.5		0.36		138.2	60.8
141.95	149.63	237.87	—	—	—	—	—

operatives with 40 dkg intact seeds + 160 dkg irradiated seeds sown per cad. hold. In order to obtain a complete poppy field, further, to determine the labour demand of thinning, the plants were thinned out in the usual way.

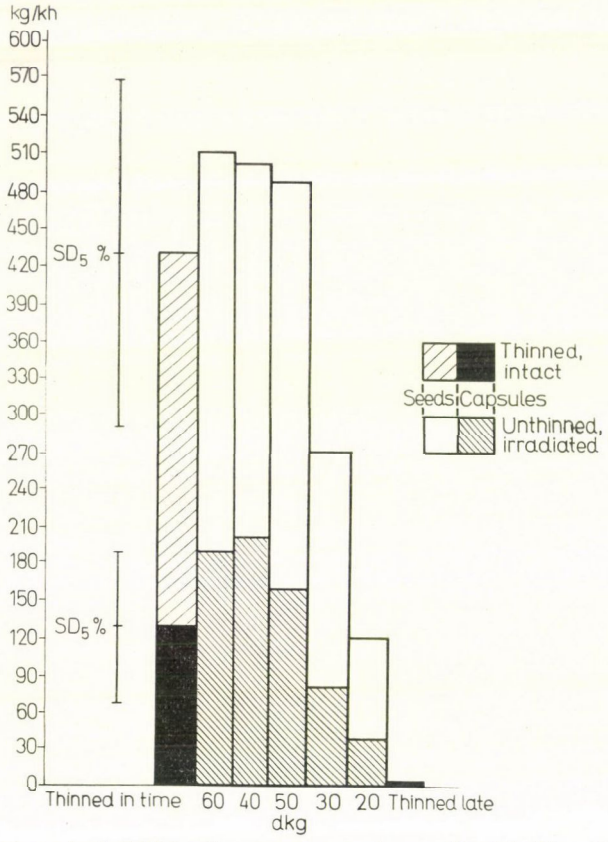

Fig. 3. The trend of yield in the poppy experiments (Budakalász, 1967)

As it is shown in Table 6 the stand was complete and the yield was practically equal to those of plots sown in the usual way. In plots sown with irradiated seed-mixtures labour input of thinning operations could be reduced by 40—50 per cent — according to a 3×10 minute measuring of performance that we had made together with the leaders of the farms.

Discussion

In order to ensure a reliable germination, dense sowing of poppy seeds is by all means necessary. Tiny poppy seeds (thousand-grain-weight = 0.40—0.50 g) sown one by one do not spring up with the expected reliability, espe-

cially when climatic and soil conditions (rainfall, seed-bed) are not very favourable. With the usual agrotechnics 20—25 times as many seeds are sown as required per unit area, thus poppy seedlings are able to help each other in breaking through the surface layer of the soil.

When the plants have 3—4 leaves, superfluous plants are thinned out. The denser the stand the more labour intensive the thinning, and a delay of this operation involves more risks as well. Therefore, besides sowing with machines and keeping the advantages of a reliable germination, growers tried to reduce the amount of seeds sown. For this purpose, prior to being sown poppy seeds were mixed with various ballast materials (grits, screened slag, sawdust, etc.). Ballast materials and poppy seeds — no matter how well they equalized before being sown — separated in the sowing machine due to the shaking and the difference of specific weight; consequently the distribution of seeds was uneven, the stand became too thick in one place and too sparse in others. This deficiency was partly eliminated by using sterilized — cooked or fried — poppy seeds as ballast material, but to ensure a reliable germination, 0.6—0.7 kg/cad. hold fertile seeds were sown (8—10 times as much as the necessary amount) which increased the unreliability of germination, though thinning still could not be neglected.

The most recent attempt to grow poppy without thinning is made by panning the poppy seeds and sowing the produced granulates one by one. If excellent seed-beds — and in dry years the possibility of irrigation — are provided for, with this method poppy growing without thinning will become possible on areas which are not exposed to the wind. Preconditions of this method are: special panning materials, panning machines and machines ensuring one by one sowing of such a material.

Small plot and medium-scale experiments carried out in 1966—1967 showed that poppy seeds treated with an appropriate dosis of radiation sprang up — as they kept their germinating ability — but showed no further development. Hence they were suitable for helping untreated poppy seeds sown together with them to emerge. In case of a proper homogenization this fact renders it possible that intact seeds able to further development are sown only in a quantity necessary to provide for the optimum number of plant per unit area. The seeds — no matter how far they are from each other in the soil — show a reliable germination — even in less suitable seed-beds and under unfavourable weather conditions — because the "active" ballast material, the irradiated poppy seeds do germinate as well. Plants need not be thinned out, as seedlings grown from irradiated seeds gradually die in 2—3 weeks. An irradiated seed-mixture containing 40 dkg/cad. hold intact seeds provided a complete stand (Tables 1—2). Here the distance between plants was 5—10 cm even at the very worst. Thus thinning to a plant distance of 10 cm — which corresponds with the present practice — was made possible. Accordingly, with irra-

diated seed-mixtures used, a poppy field can be safely planned with 120,000—150,000 plants. Anyway, the work was successfully done also by the farms listed in Table 6.

Table 6

Farm data of poppy fields sown with irradiated seed-mixtures
1967

Name	Area sown with an irradiated seed-mixture cad. hold	Yield q/cad. hold (capsules + seeds)		Labour input of thinning hour/cad. hold		
		Normal	Irrad.	Normal	Irradiated	Reduction %
State Farm, Nagymiskolc	6	8.2	11.1	—	—	—
State Farm, Szarvas	10	8.8	8.7	92.0	40.0	45.6
State Farm, Tiszavasvár	10	10.0	10.0	183.0	80.0	56.3
Co-operative Farm, Szalkszentmárton	4	6.9	7.4	—	—	—
Co-operative Farm, Fajsz	1	10.9	10.4	163.0	93.0	43.0

The irradiated seed-mixtures showed a better development than those sown with 2 kg/cad. hold intact seeds. At the time of thinning it could be well observed that using 2 kg/cad. hold intact seed, dense growth had hindered the development of plants (Fig. 4). When using 20—25 dkg/cad. hold intact seed the plants were larger, stronger and more widely spread (Fig. 5). This difference in growth remained even at the time of spearing and flowering. Statistical data show that plants were larger in plots sown with irradiated seed-mixtures (Table 3). Acceleration of growth is accompanied by better development as is shown in the number of capsules being over 5 g. Plants had significantly more capsules over 5 g in plots sown with irradiated seed-mixtures (Table 3). This observation does not stand for the seeds sown with 20—30 dkg/cad. hold intact seed, because the sowing of the small plot experiment at Budakalász on 6 March was interrupted by a rainfall of 4—6 mm. These seeds were sown therefore only on 8 March. The next rainfall occurred only on 14 March, in the same amount. As a result of the above circumstances plants sown on March 6 sprang up on March 18 and 20 while in the two other seeds only a week later, on March 25—26. Sowing and germination respectively thus being late was the cause of a delay in development.

A favourable indirect effect of sowing irradiated seed-mixtures seems to be even more important than the direct advantage of a quicker development. It appears when late thinning is considered. Thinning carried out two weeks later than the optimum time usually resulted in elongated plants and decreased resistance. Late thinning caused a serious disturbance because — due to the

Fig. 4. Plant sown with an intact seed lot of 2 kg/cad. hold before being thinned out

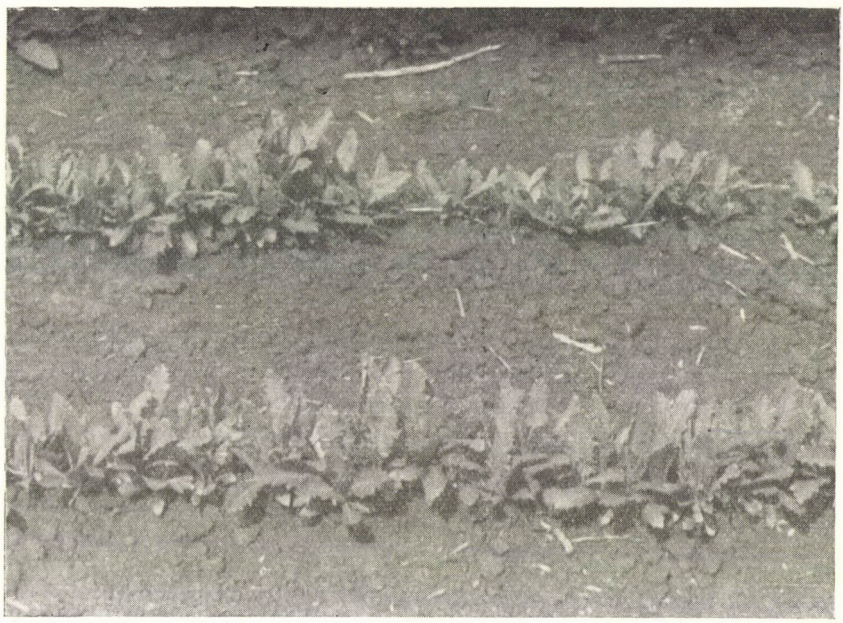

Fig. 5. Plants sown with an irradiated seed-mixture containing 40 dkg/cad. hold intact seed, before thinning

subsequent dry, hot weather — even the remained plants showed a poor development. They were apparently — and statistically too — weaker than those thinned out two weeks earlier. Late thinning causes a considerable loss of yield, since in large-scale production the thinning operations often last for two weeks and droughty years like that of 1967 are not infrequent either. Thinning operations of poppies grown from 30—40 dkg/cad. hold intact seed mixed with irradiated seed can be safely prolonged, the area is not subjected to such disadvantages.

Number of capsules per plant was the highest in seeds thinned out to a plant distance of 10 cm in due time (Table 3). Namely, wider spacing has an increasing effect on the number of capsules. RANNINGER (1916) recognized this fact as early as in 1916. Spacing is in positive correlation with the number of laterals on the plant. Author also pointed out that the higher number of capsules was in no connection with larger poppy seeds. This observation proved to be especially true in 1967 when at Budakalász between flowering and ripening the weather was droughty. (From the 11th June till harvesting only 26 mm rainfall occurred, which is about one-third of the average amount occurring usually during this period.) The capsules — no matter how much their number had increased on thinned plants — mostly remained undeveloped, their total weight was small and they contained small quantities of poppy seed.

Plants spaced closer developed less capsules but latters produced larger quantities of seeds — as the conditions were favourable for their initial development.

Under favourable weather conditions poppy plants — when spaced wider apart — are able to develop better capsules even at a later time, as it is shown by the data of the year 1966 (Table 1). In the thinned seeds the number of capsules and weight of seed per plant exceeded those of the unthinned, irradiated seeds. However, latters produced a higher yield per unit area, owing to the higher number of plant per unit area. This observation is supported by many literary data.

IVÁNYI (1963) performed a yield analysis on the basis of samples taken from 20 farms in a series of large-scale experiments. After having processed the data by the analytical method of successive regression she found that yields were determined mainly — in 89 per cent — by the number of plants. By a series of experiments conducted for two years PAPP (1965) demonstrated that the highest yield was obtained with the highest number of plants (270,000) per cad. hold applied by him.

On both experimental sites — Budakalász and Darányipuszta — in plots sown with irradiated seed-mixtures we obtained the same yield (both in capsules and seed) as in plots where seeds germinated in high percentage (300,000—600,000 seedlings per cad. hold) in spite of the drought and plants

were thinned out in time to a distance of 10 cm (Tables 4—5, Fig. 3). In 20 and 30 dkg/cad. hold seed the yield was significantly lower as a result of late sowing and germination respectively. Being 2 weeks late, thinning was especially harmful (Table 4), but even a single week delay decreased the yield by 50 per cent (Table 5). The unfavourable weather conditions made their

Fig. 6. Poppy field sown with an irradiated seed-mixture, before the harvest, in the State Farm of Szarvas in 1967

effect felt at Budakalász in capsule percentage increasing from the usual 50 per cent to about 60—70 per cent.

In Table 6 results of large-scale experiments are presented. When evaluating the yield we found that in every farm poppies sown with irradiated seed-mixtures gave practically the same crop results as those grown with the usual agrotechnics (Fig. 6). The plot sown with 40 dkg/cad. hold intact seed showed a reliable germination, plants were nowhere turned over. Working time spent to the thinning operations could be reduced by 43.0—56.3 per cent.

Systematic experiments carried out in 1967 showed that thinning operations could be omitted when seed-mixtures equalized with the present technological equipment had been sown, since the yield — even without thinning — was equal to that of plants thinned out in time. This has to be proved, in the coming years, also on large scale level.

REFERENCES

IVÁNYI, I. (1963): A mák termésalakulásának vizsgálata terméselemzéssel nagyüzemi kísérletsorozatban (Study on the trend of poppy yields by crop analysis in a series of large-scale experiments). Herba Hung., **2**, 305—317.

PAPP, J.—JÓZSA, L. (1965): A mák állománysűrűségének hatása a terméshozamra (Effect of the density of poppy stand on the yield). Debreceni Agr. Tud. Főiskola Gyak. Szakt., **7**, 75—78.

RANNINGER, R. (1916): Anfänge in der Mohnzüchtung. Zeitschrift für Pflanzenzüchtung, **4**, 45—64.

SIMON, J. (1965): Sugárforrások alkalmazása a mezőgazdasági kutatásban és termelésben (Application of sources of radiation to agricultural research and production). OAB Izotóp Intézete, 25.

TÉTÉNYI, P. (1966): Az orvosi csucsor sugárkezeléses nemesítése (Breeding of *Solanum laciniatum* by irradiation). Herba Hung., **5**, 7—15.

UNK, J. *et al.* (1965): A mák és termesztése (Poppy and its growing). Mezőgazdasági Kiadó, Budapest.

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EFFECT OF CALCIUM AND SULPHUR DEFICIENCIES ON SUGAR METABOLISM IN LINUM USITATISSIMUM L. PLANTS

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The authors' findings show that calcium and sulphur deficiencies induce alteration in the metabolism of linseed plant as is evident from the higher accumulation of sucrose in mineral deficient organs in comparison to their respective controls.

Introduction

While going through the pertinent literature it has been surprisingly noted that a very scant report is available regarding the studies on the effect of calcium and sulphur deficiencies on plants. Both of these minerals are of utmost importance for the plant growth and yet their study has been neglected. Therefore, in the present investigation it has been tried to study the deficiency effects on sugar metabolism in different parts of the linseed *(L. usitatissimum)* plant.

Materials and Methods

Linseed plant var. NR (RR) 5 was selected for the present study. Plants were grown in acid leached silica sand in enamel pots. Culture solution was given as recommended by ARNON—HOAGLAND (1940). Calcium and sulphur deficiencies were created by replacing calcium nitrate $Ca(NO_3)_2$ and magnesium sulphate ($MgSO_4 \cdot 7H_2O$) with equimolar amount of sodium nitrate ($NaNO_3$) and magnesium chloride ($MgCl_2$) respectively. For sulphur deficient plants micro-nutrient solution was slightly modified by replacing zinc sulphate ($ZnSO_4 \cdot 7H_2O$) with zinc chloride ($ZnCl_2$) and ferrous sulphate ($FeSO_4$) and tartaric acid with ferrous oxalate.

Sampling was done at two stages of plant growth (i.e. at 65 days preflowering and 75 days postflowering). Sugar detection was done by chromatographic technique (PARTRIDGE 1948 method modified by RANJAN *et al.* 1955). Quantitative estimation of the sugar was done by the iodometric method originally described by SOMOGYI (1945) but modified subsequently by WILLS—YEMM (1955).

Results

The data showing changes in sugar content in various parts of control, calcium and sulphur deficient plants have been recorded in the Table given below:

Table 1

Changes caused by calcium and sulphur deficiencies in sucrose content in various parts of linseed plants

Data expressed in mg/100 mg dry wt.

Plant parts	Control	Calcium deficiency	Sulphur deficiency
First harvest			
Root	0.189	0.199	0.210
Shoot	0.512	0.519	0.532
Leaf	0.381	0.398	0.412
Second harvest			
Root	0.160	0.175	0.198
Shoot	0.433	0.445	0.472
Leaf	0.360	0.369	0.375

Under mineral deficiencies, it was observed that sugar accumulated in increased quantity as compared to controls. At both the harvests, maximum amount of sugar accumulated in sulphur deficient plants followed by minus calcium and control plants. Furthermore, it was noticed that in all the plants maximum amount of sugar was present in the shoots followed by leaf and root at both harvests.

Discussion

The present work which emphasises a high accumulation of sugar in calcium deficient plant is quite in agreement with the published data of other investigators (BOHEM 1875, NIGHTINGALE *et al.* 1931, HOWARD 1957, TSO *et al.* 1960). According to GROOM (1896), one function of calcium is to form calcium oxalate in combination with the oxalate ions and under calcium deficiency because potassium oxalate retards the action of diastase, therefore, such plants accumulate starch. On the other hand, HARTWELL (1916) reported that starch accumulation in calcium deficient plants might have been the indirect result of the general disturbance of plant metabolism. But NIGHTINGALE *et al.* (1931) found that high carbohydrate accumulation was due to inability of calcium deficient plants to absorb and assimilate nitrate, whereas GAUCH (1940) regarded it as due to cation imbalance. The views of NIGHTINGALE *et al.* (1931) are, however, confirmed by the work of SKOK (1941) who observed that normal nitrate reductase activity was lowered in calcium deficient plants. MULLISON (1939) has reported that total respiration in calcium deficient *Pisum* and corn plants was lower than in controls. Therefore, due to the reduced rate of

respiration, sucrose could not be utilized and ultimately they accumulated. KURSANOV (1963) showed in the calcium deficient plants of *Beta vulgaris* that the phloem transport of sucrose was accelerated and the conspicuous increase was observed in the calcium deficient shoot.

Accumulation of sugar under sulphur deficiency being also noted in the present investigations, amply supports EATON's (1935, 1941, 1951) earlier results.

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REFERENCES

ARNON, D. I.—HOAGLAND, D. R. (1940): Crop production in artificial culture solutions and in soil with special reference to factors influencing yields and absorption of inorganic nutrients. Soil Sci., **50,** 463.

BOHEM, J. (1875): Über den vegetabilischen Nährwerth der Kalksalze, Sitzungsber. Akad. Wiss. Wien, **71,** 287.

EATON, SCOTT, V. (1935): Influence of sulphur deficiency on the metabolism of the soyabean. Bot. Gaz., **97,** 68—100.

EATON, SCOTT, V. (1941): Influence of sulphur deficiency on metabolism of sunflower. Bot. Gaz., **110,** 449—464.

EATON, SCOTT, V. (1951): Effects of sulphur deficiency on growth and metabolism of tomato. Bot. Gaz., **112,** 300—307.

GAUCH, H. G. (1940): Response of the bean plants to calcium deficiency. Plant Physiol., **15,** 1—21.

HARTWELL, B. L. (1916): Starch congestion accompanying certain factors which retard plant growth. R. I. Sta. Bull., 165.

HOWARD, E. J. (1957): Carbohydrate distribution as affected by calcium deficiency in cotton. Plant Physiol., **32,** 113—117.

KURSANOV, A. L. (1963): Metabolism and transport of organic substances in the phloem. Advances in Botanical Research, Vol. I, 209—278.

MULLISON, WENDELL, P. (1939): Effects of calcium deficiency on respiration of etiolated seedlings. Bot. Gaz., **100,** 828—835.

NIGHTINGALE, G. T.—ADOMS, R. M.—ROBBINS, W. R.—SCHARMERHORN, L. G. (1931): Effect of calcium deficiency on nitrate absorption and on metabolism in tomato. Plant Physiol, **6,** 605—630.

PARTRIDGE, S. N. (1948): Filter paper partition chromatography of sugars. Biochem. J., **42,** 238.

RANJAN, S.—GOVINDJEE—LALORAYA, M. M. (1955): Chromatographic studies on the amino acid metabolism of healthy and diseased leaves of *Croton sparsiflorus* Morong. Proc. Natl. Inst. Sci. India, 21B, **1,** 42.

SKOK, J. (1941): Effect of the form of the available nitrogen on the calcium deficiency symptoms in the bean plants. Plant Physiol., **16,** 145—157.

SOMOGYI, M. (1945): Jour. Biol. Chem., **160,** 161.

TSO, T. C.—MCMURTREY, J. E. JR.—SOROKIN, T. (1960): Mineral deficiency and organic constituents in tobacco plants. I. Alkaloids, sugars and organic acids. Plant Physiol., **35,** 860—864.

WILLS, A. I.—YEMM, E. W. (1955): The micro-estimation of sugars in Plants. I. New Phytologist, **38,** 125—149.

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SEASONAL CHANGES IN THE CATALASE ACTIVITY OF THE OWN ROOTED APPLE STOCK EM IV AND THE OWN ROOTED APPLE VARIETY STARKING

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For studying seasonal changes in the catalase activity of the own rooted apple stock EM IV and the variety own rooted Starking FRENYÓ's method has been used. The two apple varieties were found to exhibit different catalase activities during the vegetation period.

The differences between the lower and upper leaf positions on the trunk of the apple stock EM IV as well as those between the middle and upper leaf positions of the trunk of the apple variety Starking are significant at a probability level of P = 10 per cent.

The catalase activity of the apple varieties studied varies during the vegetation period, and the differences found in the individual phases are significant at probability levels of P = 5 per cent, P = 1 per cent and P = 0.1 per cent, respectively.

Introduction

Because of contradictory literary data, changes in the catalase activity of the different plants of two apple varieties have been studied and found that there are differences with respect to both the individual leaf positions and the vegetational phases of the varieties from May to October. In our opinion the activity of catalase may be connected with the adaptation of these varieties to environmental conditions and this may serve as an indication of metabolic changes being important from a practical point of view.

In the first part of our experiments the catalase activity of the two apple varieties mentioned above was studied. Several authors, such as DRBOGLAV (1960), NOVOPAVLOVSKAYA (1960), PINEVICH (1961), FIALOVÁ (1962) and KOZMA (1963) point out that the catalase activity of different varieties may be different.

In the second part of our experiments an effort was made to determine the differences in catalase activity between leaves at different levels of insertion. With the same individual or variety the catalase activity in different parts or regions of the plant is different. Such experiments have been carried out so far by CATTLE (1933), DELEANO (1937), BARTHA (1939), EIFERT (1955), FARKAS (1955), TURKOVA (1955), FELFÖLDI (1957), MOLOTKOVSKII (1957), DOBY (1959), DECOCK (1960), GUZUN (1960), HRISTOV—GENTCHEV (1961), KOZMA (1963). All these authors unanimously emphasize that catalase activity

varies with leaves at different levels of insertion and with different structural parts of individual varieties.

In the third part of our experiments seasonal changes in the catalase activity of the two varieties were studied.

Metabolic alterations occurring during the vegetation period are expressed in the changes of catalase activity and so are the differences in the metabolism of individual plants. These conclusions are supported by the results of CATTLE (1933), DELEANO (1937), EYSTER (1950), GARAY (1952), PÉTERFFY (1954), FARKAS (1955), MOLOTKOVSKII (1957), KINZEL (1959), SAAKJAN (1959), GUZUN (1960), NOVOPAVLOVSKAYA (1960), HRISTOV (1961), KROPACHEVA (1961), and KOZMA (1963).

Material and Method

For the experiments the own rooted apple stock EM IV and the own rooted apple variety Starking have been used.

The experiments were carried out at the experimental farm of the College for Horticulture and Viticulture at Soroksár.

The leaves were harvested during the entire vegetation period every time in 5 replicates from the lower, medium and upper third of the trunks grown in the field and analyzed using FRENYÓ's method. The samples were taken in every case at 6.30 a.m. and examined immediately at the site of sampling.

Results and Discussion

The catalase activities of the leaves at the two varieties studied are represented in column diagrams as the differences are then more apparent.

With apple stock EM IV the highest catalase activity was exhibited in the period between August 16 and September 27, i.e. just before the vegeta-

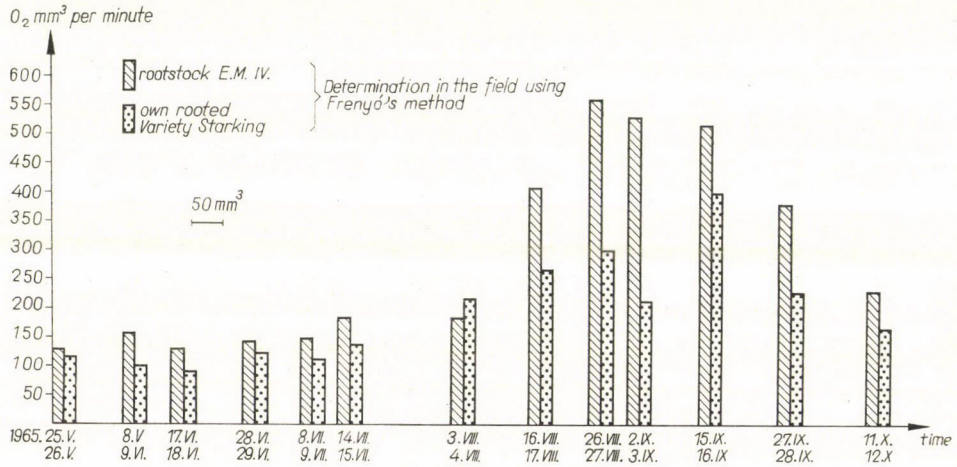

Fig. 1. Seasonal changes in the catalase activity of leaves

tion period came to an end. With the own rooted apple variety Starking catalase activity showed a gradual increase until September 15 (an exception to this trend was found on July 8 and September 2) and then a gradual decrease. With both varieties the decreasing activity of catalase from September 15 is connected with leaf senescence.

The catalase activity of the two varieties studied proved to be different.

In the case of apple stock EM IV the difference in catalase activity between the leaves of the upper and lower levels of insertion, respectively, was significant at a probability level of P = 10 per cent. The same is true for the leaves of the upper and medium levels of insertion of the own rooted apple variety Starking. The differences in catalase activity between the leaves of different levels of insertion of the two varieties shown in Figs 2 and 3 fully

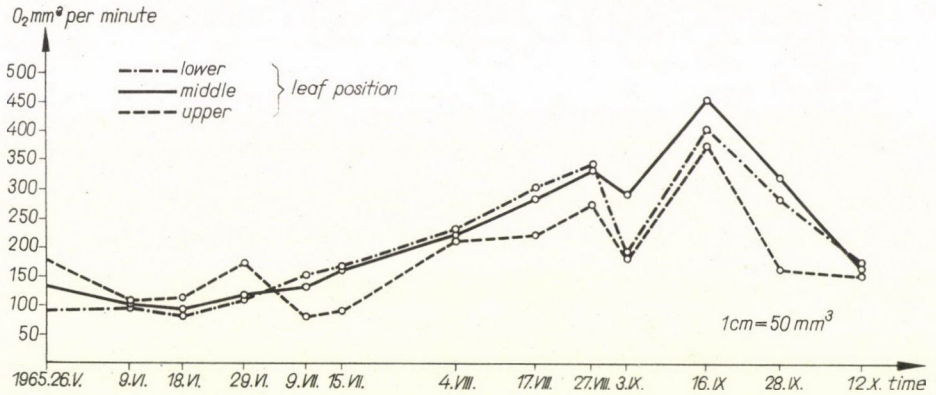

Fig. 2. Seasonal changes in the catalase activity of apple root stock EM IV

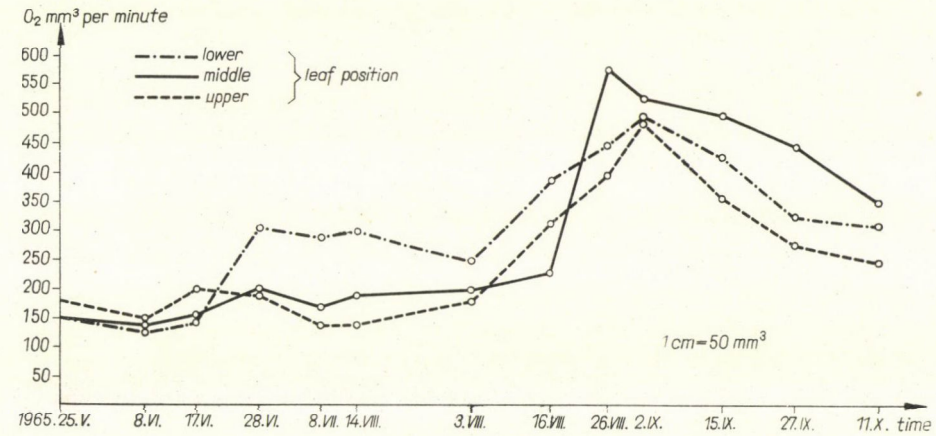

Fig. 3. Seasonal changes in the catalase activity of the own rooted apple variety Starking

support the view of the authors cited in the introduction. In our opinion a correlation may exist between the catalase activity and chlorophyll content of leaves. A similar hypothesis has been advanced by SERBIN (1954) and HANIN (1963). This is supported by our data indicating that by the end of the vegetation period (September 26 and 27) when the top leaves start to get yellow, there is a considerable decrease of catalase activity as shown in Figs 2 and 3 for the leaves of the upper level of insertion.

With the trees of apple root stock EM IV from May 25 to June 27 (Fig. 2) the highest catalase activity was found in the leaves of the upper level of insertion, from June 28 to August 16 in those of the lower level of insertion and from August 28 to October 11 there was a sudden increase in the catalase activity of the leaves of the middle level of insertion.

In case of the trees of own rooted apple variety Starking (Fig. 3) highest catalase activity was shown — from May 26 to May 28 — by the leaves of the upper level of insertion, from July 11 to August 27 by those of the lower level of insertion and from September 3 to October 12 by those of the middle level of insertion.

This change is probably connected with leaf senescence. Apple root stock EM IV begins vegetation early and finishes it relatively early. There is a shift of about 10 to 12 days as compared to the own rooted variety Starking. With root stock EM IV the fluctuations of catalase activity from leaf position to leaf position are more pronounced than in the case of the own rooted apple variety Starking.

Changes in catalase activity were established between the two varieties in different phases of their vegetation period, i.e. in spring (May and June), in summer (July and August) and in autumn (September and October).

The differences between the determinations were significant at the following levels of probability:

Apple stock EM IV. Between the determinations carried out in autumn and in spring, respectively, $P = 0.1$ per cent. Between the determinations carried out in spring and in summer, respectively, $P = 1$ per cent. Between the determinations carried out in summer and in autumn, respectively, $P = 5$ per cent.

The own rooted apple variety Starking. Between the determinations carried out in autumn and in spring, respectively, $P = 0.1$ per cent. Between the determinations carried out in summer and in autumn, respectively, $P = 1$ per cent. Between the determinations carried out in summer and in spring, respectively, $P = 5$ per cent. In the individual vegetation periods both the varieties and the different leaf positions can be clearly distinguished.

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REFERENCES

BARTHA, L. (1939): Enzymuntersuchungen während der Trocknung des grünen Tabaks. Z. f. Unters. Lebensm., **78,** 322—327.

CATTLE, M. (1933): Studies of the physiological importance of the mineral elements in plants. V. The distribution of diastase, invertase and catalase in normal and potassium-starved bean plants. New Phytol., **32,** 364—381.

CHERNENKO, E. S.—Черненко, Е. С. (1953): Влияние ментора на изменение морфологических и физиологических свойств гибрида между грушей и яблоней. Журн. Общ. Биол. **145,** 369—387.

DECOCK, P. C. *et al.* (1960): Interrelationships of catalase, peroxidase, hematin and chlorophyll. Plant Physiol., **35,** 599—600.

DELEANO, N. T. *et al.* (1937): Contribution à l'étude de la catalase végétale. Bull. Soc. Chim. Biol. Paris, **19,** 898—910.

DOBY, G. (1959): Növényi biokémia (Plant Biochemistry). Akadémiai Kiadó, Budapest, 665.

DRBOGLAV, M. A.—Дрбоглав, М. А. (1957): О методике определения активности каталазы в органах и тканях виноградной лозы. Виноделие и виноградарство. **1,** 63—64.

EIFERT, A. (1955): Kataláz aktivitás változása citromfélék leveleiben (Changes in the Catalase Activity of Citrus Leaves). Agrokémia és Talajtan, **4,** 217—224.

EYSTER, H. C. (1950): Catalase Activity in Chloroplast Pigment Deficient Types of Corn. Plant Physiol., **25,** 630—639.

FARKAS, G. L.—RAJHÁTHY, T. (1955): Untersuchungen über die xeromorphischen Gradienten einiger Kulturpflanzen. Planta, **45,** 535—548.

FELFÖLDY L.—GELLÉRT, J.—SEBESTYÉN, O. (1957): Kísérletek növényi katalázzal. Anyagcsere különbségek kimutatása kataláz aktivitás méréssel egy növényen belül (Experiments on plant catalase. Estimation of metabolic differences in one plant by measuring catalase activity). Annales Instituti Biologiae Scientiarum Academiae Hungaricae, Tihany, 1955—1956, **24.**

FIALOVÁ, S.—DOBREMYSLOVÁ, M. (1962): The Activity of Catalase and Phosphatase in Wheat when Controlling the Growth Rate. Biol. Plan., **4,** 182—190.

FRENYÓ, V. (1962): Method and Device for the Examination of Processes Connected with Gas Formation. Szabadalmi Közlöny, **67,** 279.

GARAY, A.—ANTAL, E. (1952): Tájékozódó kísérletek a gyapot termés elrúgásának növényélettani és biokémiai okairól (Preliminary experiments on the physiological and biochemical causes of fruit abscission in cotton plants). Agrokémia és Talajtan, **1,** 353—368.

GUZUN, N. I.—Гузун, Н. И. (1960): Влияние разнокачественности побегов винограда на выход привитого посадочного материала. Виноделие и виноградарство. **20,** 2, 35—38.

HANIN, J. D.—Ханин, Я. Д. (1963): Активность каталазы и содержание хлорофилла в листьях винограда под влиянием удобрения. Садоводство, Виноградарство и Виноделие Молдавии. **2,** 29—31.

HRISTOV, S.—GENTSEV, S. P.—Христов, СТ. — Генчев, С. П. (1961): Провичвания върху физиологичните особенности на уякой сортове и хибридни комбинации пипер. Известия на Центральная Научно-Исследователски Институт по Зеленчукови Културы. Марица, Пловдив. Книга, **1,** 29—43.

KAJMAKAN, I. V.—каймакан, И. В. (1958): Причины гибели некоторых сортов груш, привитых на айве. Садоводство, Виноградарство и Виноделие Молдавии. **13,** 14—16.

KOZMA, P. (1963): A szőlő termékenységének és szelektálásának virágbiológiai alapjai (Flower biological basis of the fertility and selection of grape). Akadémiai Kiadó, Budapest, 494.

KINZEL, M. (1959): Katalasebestimmungen an grünen Blättern. **7,** 835—850.

KROPACHEVA, F. C.—Кропачева, Ф. Ц. (1961): Активность окислительных ферментов в листьях однолетных и двулетних яблонь. Уч. Зап. Омского Гос. Пед. Ин-та. **14,** 3—12.

MOLOTKOVSKII, G. H.—Молотковский, Г. Х. (1957): Содержание хлорофилла аскорбиновой кислоты и активность каталазы в листьях некоторых плакучих форм древесных растений в связи с явлением полярности. Докл. АН СССР. **113,** 5, 1165—1167.

NOVOPAVLOVSKAYA, N. V.—Новопавловская, Н. В. (1960): Активность каталазы у корнесобственных растений винограда и привитых на морозостойкие подвои. Бюл. Центр. Ген. Лабор. им. И. В. Мичурина.

PÉTERFFY, I. (1954): A növények növekedésének és fejlődésének élettani alapjai (Stádiumos változások összefüggése) [Physiological basis of plant growth and development (Stadial changes)]. University of Cluj.

PINEVICH, V. V.—Пиневич, В. В. (1961): Влияние различных форм азотных удобрений на активность каталазы и пероксидазы в зерне пшеницы и ячменя. Физиол. Раст. **8, 2,** 205—212.

SAAKJAN, R. G.—Саакян, Р. Г. (1959): О некоторых биохимических процессах у разных по морозостойкости сортов винограда. Физиол. Раст. **6,** 2, 219—221.

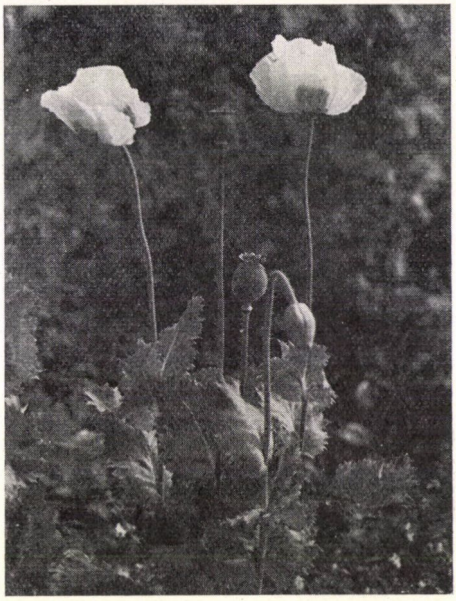
SERBIN, S. S.—Сербин, С. С. (1954): Вплив поракреннетс живленне и пидживлення на физиологични процесси у Цукроух банякив. Виник АН УССР. **2,** 29—37.

TURKOVA, N. Sz.—Туркова, Н. С. (1955): Обмен веществ и рост растений. Вестн. Моск. Ун-та.

Acta Agronomica Academiae Scientiarum Hungaricae, Tomus 19 (1—2), pp. 171—204 (1970)

VARIA

SB MORPHIC POPPY



Taxonomical position: *Papaver somniferum* L. var. *caesium* DC.

Origin: produced from the variety Hatvani by individual selection owing to its high productivity.

Beginning of breeding: 1951, Budapest—Alsógöd.

State qualification: provisionally certified improved variety, 1959; state certification in 1960.

Breeders: Sándor Sárkány, Irén Sárkány, Béla Dános, Budapest.

General characteristics: a blue seeded poppy variety with relatively low culture demands, good resistance, high productivity and morphine content (KAPÁS *et al.* 1965).

Morphological description:

Root system: tap-like root of 1—2 cm diameter penetrating the soil to a depth of 50—90 cm, with a low number of secondary roots. Strong root system.

Shoot system: 115—135 cm high, firm plant with 3—6 laterals. The upper third of the main stem and laterals (below the flower) is moderately bristled (SÁRKÁNY 1960).

Stem: when developed stiff, cylindrical and with moderately waxy surface.

Foliage: the scattered elliptical leaves are wide and slightly waxy. Colour bluish green, leaf apex sharp, edges slightly dentate, hairy. When the plant has reached opium maturity (at the end of June) the number of leaves on the main stem is 17—20 and the length of the fully developed leaves is 23—26 cm (SÁRKÁNY *et al.* 1962).

Flowers: buds are wide, egg-shaped, sharp at the tip. Petals of open flowers are white with a light lilac spot at the base.

Fruit: flattened, pear-shaped capsule, with a neck drawn in at the base and with a cylindrical formation at the top. Stylopodium flatly arched, slightly concave at the centre. Number of stigmulae is generally 12—14. Capsule is closed, greyish-green and slightly waxy when maturing and yellowish-brown when ripe. Each plant has 4—5 capsules. Morphine base content of dry capsules fluctuates generally between 4.5 and 6.5 per mille depending on the influence of weather (SÁRKÁNY 1960). Capsule height equilibrium (that is, the position of 90 per cent of the capsules from the stylar end of the uppermost capsule to the base of the lowest one) is 46.9 cm (SVÁB *et al.* 1968).

Seed: lighter or darker steel blue. Thousand-grain-weight 0.43—0.45 g. Fatty oil content of seeds is, on average, 45.9 per cent (range: 44—46 per cent).

Biological characters:

Germination: cardinal points: minimum +3°C, optimum 25°C, maximum 35°C (SZABÓ unpubl.).

Vegetative period: of medium length, 130—140 days (sowing in the middle of February).

Water requirement: up to the time of flowering 190—200 mm, from the time of flowering to capsule maturity 70—80 mm precipitation is required for a favourable development (MÁNDY unpubl.).

Resistance to diseases: resistant.

Farm technology requirements:

Seeding: as early as possible (in February), careful shallow (KAPÁS *et al.* 1965) sowing.

Soil requirement: soil should be properly cultivated especially at the initial phase of development (but also at the time of emergence).

Productivity: average yield expressed in empty capsules 641 kg/ha, in seed production 671 kg/ha (IVÁNYI 1967). Productivity higher than medium.

Region of cultivation: it is successfully grown throughout Hungary, especially in the Great Hungarian Plain and Trans-Tisza (KAPÁS *et al.* 1965).

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Prepared at the National Institute of Agrobotany, Tápiószele

GY. MÁNDY

REFERENCES

IVÁNYI, S. (1967): Adatok néhány mákfajta értékbírálatához (Contribution to the evaluation of several poppy varieties). Nemesített Növényfajtákkal Végzett Országos Fajtakísérletek eredményei. OMFTMI., Budapest, 235—248.

KAPÁS, S. *et al.* (1965): Nemesített növényfajtáink (Our improved plant varieties). Mezőgazdasági Kiadó, Budapest.

SÁRKÁNY, S. (1960): A mák rendszertani viszonyai és a fajon belüli egységek értékelése (Systematic relationship of poppy and unity appreciation within the species). In BARTOS—MÓRÁSZ—SÁRKÁNY—UNK—ZSOÁR: A mák és termesztése (The poppy and its cultivation). Mezőgazdasági Kiadó, Budapest, 28—38.

SÁRKÁNY, S.—MICHELS-NYOMÁRKAY, K.—ANDRÁSFALVY-VICENTY, M. (1962): Versuche über die Verteilung der Nebenalkaloiden während der Vegetationsperiode der Mohnsorten SB und SD. Annales Univ. Sci. Budapestiniensis de Rolando Eötvös nom. Sect. Biol., **5**, 225—242.

SVÁB, J.—BAKOS, ZS.—KISS, T.—IVÁNYI, S. (1968): Rostlen-, rostkender- és mákfajták értékelési módszere összesített gazdasági értékmutatóval (Evaluation method of fibre flux-, fibre hemp, and poppy varieties by using a complex economic value index). Nemesített Növényfajtákkal Végzett Országos Fajtakísérletek Eredményei 1967. OMFTMI., Budapest, 83—92.

ORIGINATION OF LATERAL ROOTS ON SPROUTING PLANTS OF RICINUS COMMUNIS L.

Since the work of NÄGELI and LEITGEB appeared in 1867, the origination of the lateral roots of *Ricinus* has been mainly described in text-books and practical manuals (TROLL 1954, SÁRKÁNY—SZALAI 1966). These works generally describe the origination of the lateral roots of *Ricinus* as acropetal in regard to the primary root. Several authors refer to hypocotyl roots, but they either provoked experimentally the development of such roots on isolated hypocotyl stem parts or observed hypocotyl roots on young plants (RAUH 1941). Belonging to the same family as *Ricinus*, *Euphorbia lathyris* also presents hypocotyl roots after the formation of lateral roots on the primary root (WEINHOLD, 1967). After having published

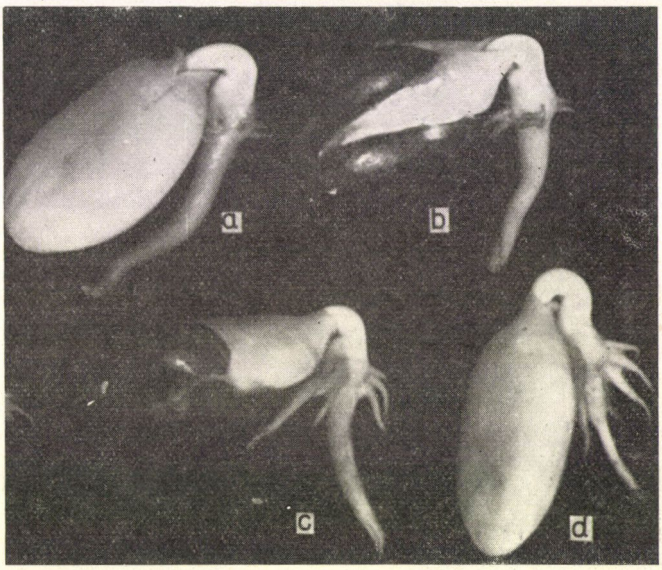

Fig. 1. Ricinus communis seedlings in different stages of development: after the first lateral root level the second set of four lateral roots develops in the sense of the cotyledons (a, b); appearance of the third basipetal lateral root level (c, d). (M = 1 : 2)

a paper on lateral roots of the pea (GRACZA 1967), the author of the present paper wished to find out whether there was any root formation on the hypocotyl stem part of *Ricinus*, and if so what was the difference in time and site between it and the acropetal lateral roots.

The seedlings required for the test were cultivated partly in a Petri dish and partly on free field. Beginning with the start of sprouting, morphological examinations were carried out and material was gathered for histological elaboration in several stages. Histological observations were made on manual and microtomic sections, the latter having been prepared with the usual micro-technique and embedded in paraffine. Histological particulars being characteristic morphologically are reproduced on photos and micro-photos.

On the third day of sprouting the seed-husk bursts out and the radicle grows for a while horizontally; then it becomes incurbed and continues to develop in a positive geotropic way. On the radicle of 1—1.5 cm length, under the widening transition region (root neck), immediately along the median and transversal plane — in 30—40 p.c. of cases, along the diagonal planes as well — the primary cortex swells, then bursts and four lateral root primordia appear

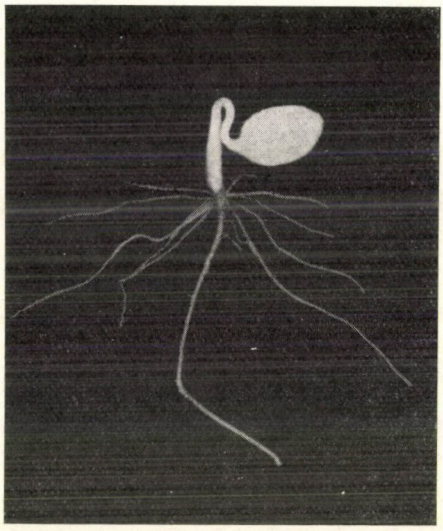

Fig. 2. Typically acropetal lateral roots developing after and under the basipetal lateral roots. (M = 1 : 1)

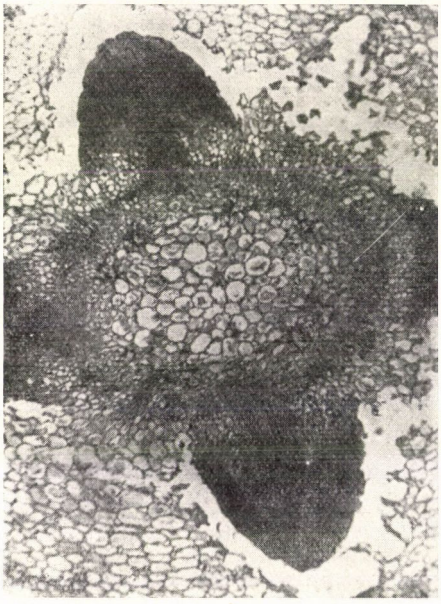

Fig. 3. The second lateral root level in the root neck. The xylem and phloem bundles are already divided. (Obj. 20×, oc. 5×)

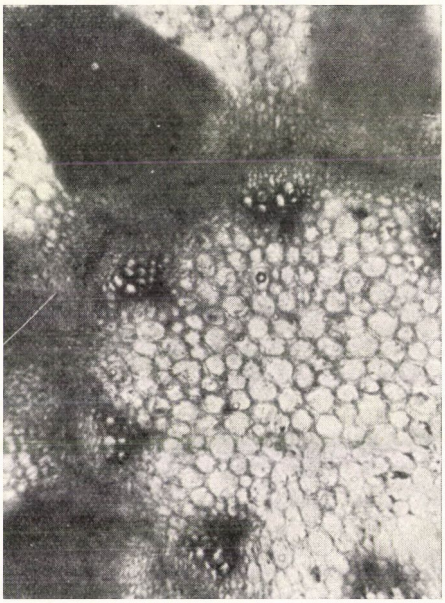

Fig. 4. Third lateral root level at the border of the transition region (root neck) and the hypocotyl, with collateral compound vascular bundles. (Obj. 20×, oc. 5×)

in the root-hairy zone. In this stage the growth of the young primary root slows down, while in the transition region four further lateral root primordia appear in the sense of the cotyledons. On 50 p.c. of the seedlings another root level develops on the border of the transition region and the tapering hypocotyl. The lateral roots of these two or three levels appear along four regular ortostichons and proceeding upwards they become shorter and shorter. Since these lateral roots come into being in the direction of the cotyledons, the author terms them basipetal lateral roots. Subsequently the new lateral roots develop at the level below the above-mentioned

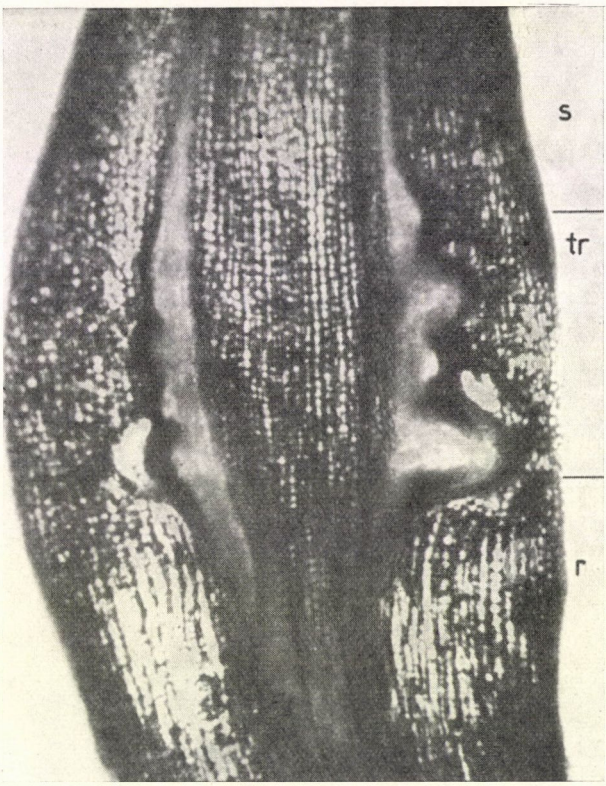

Fig. 5. Longitudinal section of seedling root with lateral root primordia shortening towards the hypocotyl. r = primary root; tr = root neck; s = hypocotyl. (Obj. 6.3×, oc. 5×)

basipetal lateral roots, on the younger stage of the primary root, with a typically acropetal character. These acropetal lateral roots appear along orthostichons that are not so regular as the former ones; there are twot—there—four lateral roots to be observed in the different levels (Figs 1 and 2).

The histological examinations have been effected on transversal and longitudinal sections. In general the young seedling roots are tetrarch up to 60—70 p.c., seldom hexarch (10 p.c.) and octarch up to 20—30 p.c. The present work deals with the tissue structure of tetrarch roots and the examinations begin at the first lateral root level developed under the transition region. On the surface some cells of the rhizodermis consisting of a single cell row elongate and become long root-hairs. The rather wide primary cortex is closed by a Caspary-

striped endodermis. Following the pericambium of the stele four xylem bundles can be observed along the median and transversal planes, and four phloem bundles in the diagonal planes. In this stage the xylem bundles begin to get apart in a winglike way along the metaxylem elements. In the other root level the xylem bundles also divide in two and gradually bend towards the phloem bundles dividing as well. In the third lateral root level the divided and convergent xylem and phloem bundles touch each other by their sides and become collateral open bundles. The lateral roots take their origin between two compound bundles each. The longitudinal section of the young root shows the formation of basipetal lateral roots in form

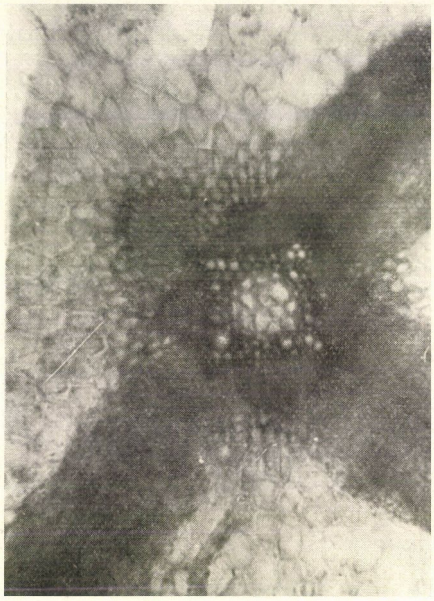

Fig. 6. The fourth lateral root level with advanced secondarily thickened vascular tissue system. (Obj. 20×, oc. 5×)

of swellings, becoming always smaller as we proceed upwards. The fourth lateral root level, growing downwards acropetally, is developing from the secondarily thickened primary root, from the direction of the simple xylem bundles. At the same time, the vascular tissue system in the transition region and the hypocotyl stem part has hardly increased in this stage (Figs 3 to 6).

By way of summary: on *Ricinus* seedlings the lateral and hypocotyl roots appear first on the transition region and hypocotyl stem part, while the well-known acropetal lateral roots appear only afterwards, under their level. The author terms this form of root organization bipolar lateral root growth.

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REFERENCES

GRACZA, P. (1967): Einige Bemerkungen zur Wurzelorganisierung des *Phaseolus vulgaris* L. Botanikai Közlemények, **54**, 1.
NÄGELI—LEITGEB (1867): Entstehung und Wachstum der Wurzeln. Beitr. zur wiss. Bot., 89.
RAUH, W. (1941): Morphologie der Nutzpflanzen. Leipzig.
SÁRKÁNY, S.—SZALAI, I. (1966): Növénytani Praktikum, I. Növényszervezettani Gyakorlatok (Botanical Practice), Budapest.
TROLL, W. (1954): Praktische Einführung in die Pflanzenmorphologie, Jena.
WEINHOLD, L. (1967): Histogenetische Studien zum Grenzwurzelproblem. Beiträge zur Biologie der Pflanzen, **43**, 367—454.

GERMINATION STUDY OF SOME WEEDS

It is known that germination of weed-seeds is not uniform and can be retarded even for years. Seeds of various species differ extremely in viability and duration of life (KOZLOVA 1962). It is enough to mention *Convolvulus arvensis* which has — according to CZIMBER (1968) — hard coated seeds in 90—98 per cent.

Many authors have dealt with the distribution and coenological conditions of weeds but data on their physiological properties at germination are sparse and insufficient. KOSIKOVA (1960), WIBERG—KOLK (in RUHLAND 1965) treated the seeds of some ruderal plants with gibberellin solutions of 50—500 ppm and found that various species responded differently to the treatment as compared with the control which did not germinate at all. According to BENCZE's studies (1959) late summer weeds constituting the majority of the total amount of weeds require germination temperatures of 20—30°C.

The germination laboratory of our Institute has tried to complete the insufficient data with some new ones. Seeds were collected in the stage of full ripeness in 1967 in the location of Tápiószele.

Sensitivity of seeds of a number of weed species has been studied: whether the influence of light, pre-cooling and gibberellin solution of 100 ppm promotes their germination in comparison with the control germinated in darkness — or they are indifferent. In a smaller group of species having well germinating seeds we studied the cardinal points of temperature.

In the experiment 3×100 seeds were germinated in Petri dishes between two layers of filter paper with the required temperature secured by biological thermostats. Germination was carried out in October and repeated in March.

Sodium chloride solutions of 0.5, 1.0, 2.0 and 3.0 per cent were used for studying the salt tolerance.

Germination in all varieties often lasted as long as a month.

Weed species responded differently to pretreatments. The results of examinations were the following:

	Germination percentage of	
Light sensitive species:	untreated seeds	treated seeds
Lepidium cartilagineum	6	90
Matricaria chamomilla	39	85
Galium mollugo	50	80
Achillea asplenifolia	25	76
Lepidium ruderale	5	60
Lepidium draba	10	50
Pastinaca sativa	0	21
Treatment with aqueous gibberellin solution of 100 ppm (in darkness):		
Plantago lanceolata	15	80
Leonurus cardiaca	60	80

Sisymbrium sophia	10	75
Lycopus exaltatus	5	70
Verbascum blattaria	30	60
Myagrum perfoliatum	11	30
Hyoscyamus niger	1	30
Plantago indica	4	26
Chenopodium album	2	10
Pre-cooling for 3 days at 4—5°C (in darkness):		
Lactuca serriola	78	92
Limonium gmelini	67	77
Amaranthus retroflexus	1	20
Datura stramonium	1	13
Indifferent species:		
Silene cucubalus	95	
Epilobium hirsutum	90	
Echinochloa crus-galli	75	
Conium maculatum	70	
Vicia segetalis	70	
Althaea officinalis	45	
Sisymbrium orientale	45	
Aster pannonicus	40	
Arctium lappa	30	
Nigella arvensis	30	
Daucus carota	20	

Seeds of several species, with a few exceptions, did not germinate either in autumn 1967 or in spring 1968: *Erigeron canadensis*, *Galium aparine*, *Lappula myosotis*, *Oenothera biennis*, *Ornithogalum boucheanum*, *Portulaca oleracea*, *Saponaria officinalis*, *Solanum nigrum*.

We have also determined at germination the temperature requirement of seeds of some frequently used plant species germinating well in darkness and in soil under natural conditions (Table 1).

As the table shows the cardinal points of the temperature at germination are considerably varying.

Table 1

Cardinal points of germination temperature
Tápiószele, 1967

	5	10	15	20	25	30	35	40	Pre-cooling for 2 weeks at 5°C
	°C								
Lactuca serriola	0	*79*	71	57	39	6	0	0	93!
Lepidium campestre	0	88	*92*	54	6	2	0	0	45
Matricaria chamomilla	0	12	41	*74*	44	20	0	0	73
Silene cucubalus	0	68	89	*98*	97	64	11	0	97
Conium maculatum	0	24	63	67	*68*	14	0	0	45
Cichorium intybus	0	8	62	81	*85*	82	48	0	44
Amaranthus blitoides	0	13	25	76	*88*	83	82	45	58
Marrubium peregrinum	0	38	69	90	*91*	80	50	3	88
Limonium gmelini	0	20	44	57	53	*67*	44	2	78!

Lactuca serriola: germinates optimally at 10°C except for seeds pre-cooled for two weeks at 5°C giving even better results. 30°C decreases the germinative ability to a considerable extent. The plant requires low temperatures for germination.

Lepidium campestre: seeds behave similarly to the former plant. Maximum germination occurs at 15°C; at 25°C there is already a considerable decrease.

Matricaria chamomilla: germinates optimally at 20°C; there is a considerable decrease at both 10 and 30°C.

Silene cucubalus: germinates well at a temperature as low as 10°C; its optimum is at 20—25°C but germinates even at 35°C.

Conium maculatum: optimum temperature of germination is 25°C; it is interesting that germination percentage falls suddenly at 30°C, while at lower temperatures it shows fairly good values.

Cichorium intybus: requires rather high temperatures though its optimum germination temperature is 25°C; however, its germinative ability is satisfactory at higher temperatures (even at 35°C).

Amaranthus blitoides: shows the highest germination percentage at 25°C but germinates well even at 40°C.

Marrubium peregrinum: germinates rather well at its minimum germination temperature of 10°C, while shows a low percentage at its 40°C maximum.

Limonium gmelini: germinates best at 30°C while at 10 and 40°C its germination percentage is low.

The course of germination is interesting and often more meaningful. If optimum germination temperatures are considered from this point of view minor differences occur when compared to the values determined on the basis of germination percentage. In general, at higher temperatures the rate of germination is higher but the number of germs may not be so high. With *Lactuca serriola* e.g. germinating vigour is optimum at 20°C already on the second day. *Silene cucubalus* too has a higher rate of germination at 25°C. *Cichorium intybus* has its highest rate of germination at 30°C while *Amaranthus blitoides* at 35°C.

At low temperatures germination is prolonged, it generally begins a week later and lasts for two weeks. On the other hand, at higher temperatures germination is more rapid, often starts on the second day and is at its highest rate on the third or fourth day. However, germination lasts even in this case for one or two weeks since a few seeds germinate even on the last days.

Seeds of various species germinated at room temperature on germ beds soaked with various concentrations of sodium chloride are of different sensitivity. *Lactuca serriola* reacts sharply to a concentration as low as 0.5 per cent, germination percentage is 2 per cent compared to the 72 per cent of the control. *Cichorium intybus* is also sensitive (fell from 63 to 10 per cent). *Lepidium campestre* and *Marrubium peregrinum* are of medium sensitivity and *Matricaria chamomilla* and *Amaranthus blitoides* show low reactions. *Silene cucubalus* and *Conium maculatum* are sensitive to a 1 per cent solution of sodium chloride, when germination percentage decreases considerably: from 60 to 12 per cent and from 80 to 2 per cent respectively. *Limonium gmelini* displays a very high salt tolerance, since under the influence of a 2 per cent sodium chloride solution germination percentage fell from 70 to 25 per cent and to 3 per cent only when treated with a solution of 3 per cent.

Our examinations suggest that simple germination studies may produce data interesting and useful also perhaps from a practical point of view.

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Prepared by the National Institute of Agrobotany, Tápiószele.

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REFERENCES

BENCZE, J. (1959): Kedvező őszi időjárás hatása a gyommagvak csírázására (Effect of a favourable autumn weather on the germination of weed-seeds). Magyar Mezőgazdaság, **14**, 4.

CZIMBER, GY. (1968): Legkárosabb gyomnövényeink (The most harmful weeds of Hungary). Búvár, **13/1**, 25—28.

KOSIKOVA, P. G.—Кошикова, П. Г. (1960): Прорастение семян некоторых видов сорных и рудеральных растений при обработке их растворами гиббереллиновой кислоты различной концентрации. Докл. А. Н. СССР, 130/4 : 922—924.

KOZLOVA, Z. I.—Козлова, З. И. (1962): Жизнеспособность семян сорных растений в почве. Труды Всес. Научно-иссл. Инст. Удобр. и Агроп. **39**, 243—259.

RUHLAND, W. (1965): Handbuch der Pflanzenphysiologie. **15/2**, Springer, Berlin—Heidelberg—New York.

WAGNER, J. (1908): Magyarország gyomnövényei (Weeds of Hungary). Pallas RT., Budapest.

A NEW ECOLOGICAL METHOD OF PLANT BREEDING

(Preliminary report)

Investigations carried on for more than fifteen years suggest that every yield aspect of crop stands depends decisively on weather conditions prevailing during the growing season (MÁNDY 1963, 1966). Experiments have shown that not only the quantity but also the quality of yield is in close relation with the rhythm of development in crop stands, which is controlled mainly by the weather.

Weather acts generally in two directions: (1) influences the growth rhythm as well as every morphological and metabolic momentum of the individual plants and (2) has a considerable effect on the performance of the stand and even on future trends in its composition. Weather has mostly a modifying effect on individual plants, hereditary changes are very rare, while its influence on the stand involves always genetic consequences, it transforms the genetic composition of the stand. According to our investigations (MÁNDY 1966, 1967) the influence exerted on the stand results in individual plants unable to adapt themselves to the circumstances either perish (by frost, wither, etc.) or produce very few seeds and gradually disappear from the stand. In a climatically peculiar area this process brings about "local" varieties, ecotypes or ecovariations developing from the original population by a genetic reorganization of the stand.

The fact of "natural selection" manifesting itself day by day in crop stands suggests that plant breeders have to take advantage of the selective effect of weather in order to make breeding work quicker and more efficient. Namely, the following method has been used so far in breeding work all over the world: the basic material is sown at a time considered suitable. The basic material develops under the influence of the current weather conditions and the phenotype of the individual plants as well as variation of their characteristics reflect the actual peculiarities of the prevailing weather. It would be a great fortune if the effect of weather coincided with the aim of the breeder, but in practice this possibility can hardly be reckoned with. Thus the breeder involuntarily accepts selective possibilities "offered" by weather and can find out the results only when it is late.

On the basis of what have been said the further course of breeding, its success or failure depend considerably on the weather prevailing at the initial phase of development of the selected basic material and on the possibilities it offers to the breeder for the selection of seed parents. It is a question to what extent the actual weather evokes from the basic material the good characteristics incorporated in plus variants. According to the results of our experiments it is sure that long prevailing weather conditions more or less limit genetic variation

in a stand, so the breeder has not the possibility of finding out the maximum values of his basic material. Thus, weather itself usually restricts the efforts of the breeder. This restriction is continued in the seed parent plot, when the progeny of the selected plus variant gets into different, usually unfavourable environment so the performance expresses Galton's principle of "regression" (Fig. 1). The mean value of the progeny of the plus variant regresses to the mean value of the basic material. Thus, the next selection impairs involuntarily the results, because the plus variant selected from the seed parent plot can naturally be of reduced

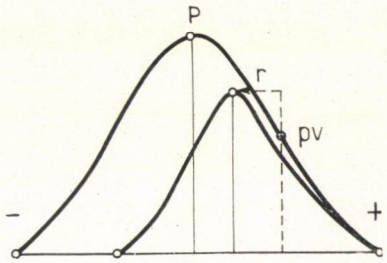

Fig. 1. Plotting of Galton's "regression". P = variation curve of the basic population, with the variation curve of the progeny of plus variants (pv) and the extent of regression (r) (horizontal broken line)

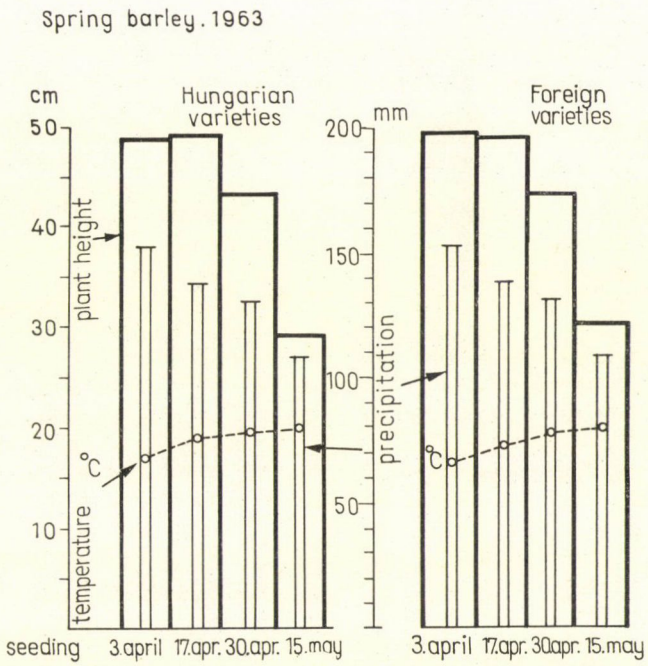

Fig. 2. Relationship between the most important weather data during the growing season and the average plant height of spring barley in the experiment carried out at Tápiószele in 1963. Wide columns show the average plant heights of Hungarian and foreign barley varieties planted at different dates (cm); narrow columns (within the wide ones) show the amount of precipitation, while small circles within them (connected with broken line) the mean temperatures of the growing season

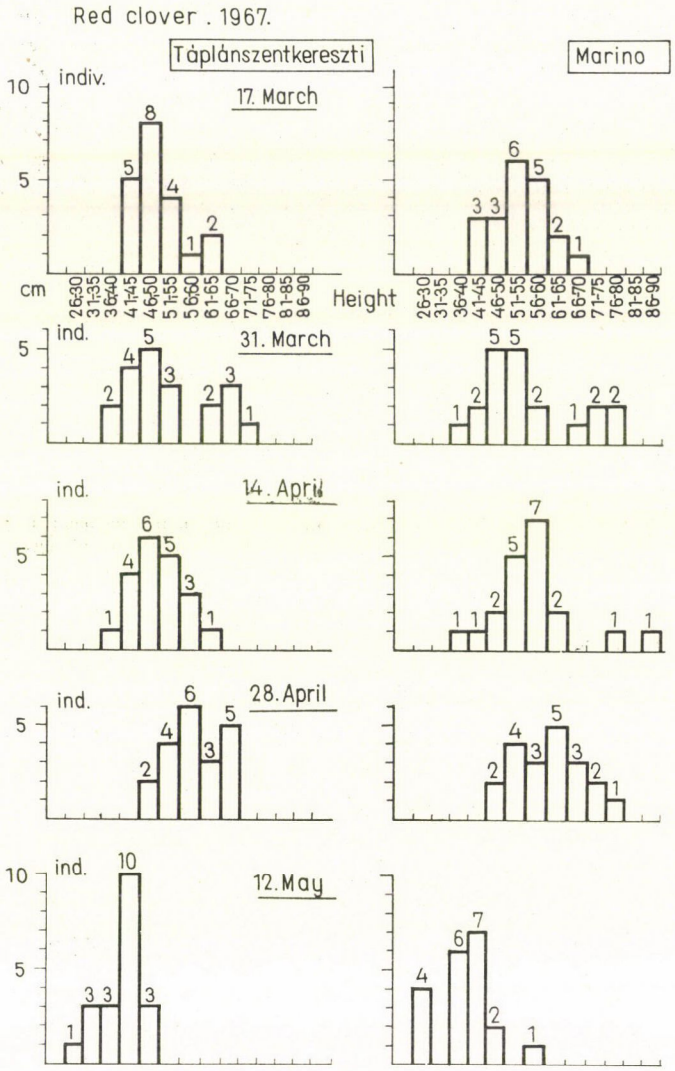

Fig. 3. Plant height variation of the two red clover varieties sown at different dates at Tápiószele in 1967. Columns show the number of examined entities in the variation groups

capacity, since weather conditions cannot be as favourable in the next year as they were at the time of the plus variant seed parent.

What can be the reason for reduced performances (apart from different weather)? The genetic factors providing resistance to the influence of weather are involuntarily limited by the selection bringing the plus variant values to surface. This increases ecological sensitivity in the progeny. And ecological sensitivity, in turn, inhibits performance under unfavourable weather conditions. Thus, even if we succeed in increasing the value of the selected character, we reduce the ecological resistance and enhance unreliability of yields. The very aim of plant

breeding is, however, to increase performance, keeping simultaneously ecological resistance and the annual yields stable.

In order to achieve the above conditions, the ability of ecological resistance in a wide range must be maintained in addition to improving useful characteristics. Therefore it is necessary that selection of plus variants should take place under varying ecological circumstances (first of all different weather conditions). My investigations suggest that the planting of source material is most appropriate at different dates, thereby putting it in an ecological series. Namely, by sowing at different dates a varying course of weather factors can be developed under the same growing conditions, in which the values of weather elements change gradually (Fig. 2). Height values of the figure follow well the changes of weather elements showing also the differences between the means of domestic and foreign varieties.

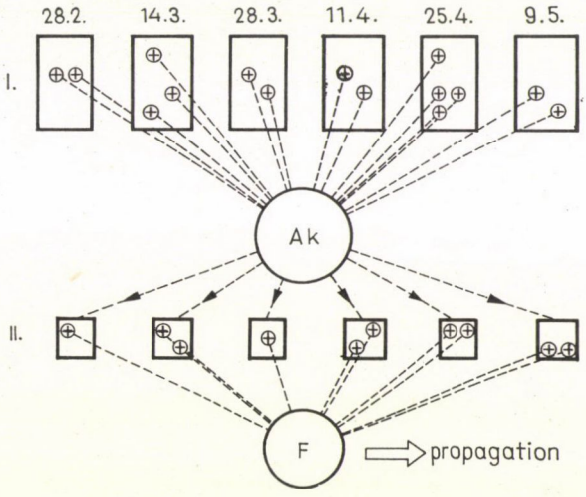

Fig. 4. The new ecological breeding method outlined by the example of the poppy. Squares indicate the plots, crosses in small circles the plus variants, large circles the seed. Signs and abbreviations used: dates indicate the sowing dates, numbers the generations, Ak = mother plant mixture, F = seed collected in the second year, which can be propagated

Theoretical bases of the new ecological plant breeding method are shown even better in Fig. 3. It shows the variational distribution of individual height-measurements taken in five plots of two red clover varieties planted at different dates (the best Hungarian and German variety, respectively) with the number of plants graded into variation groups characterized by 5 cm grade values. Data show the range of variation to be changing by the time of sowing and there are substantial differences between the varieties in this respect. Suppose, the breeding starts in 1967 and the breeder has sown his two populations (two varieties) at the earliest date, on the 17th March, according to the growing plan. If we look at the variation of plant height (the character in question), with the variety Tápiószentkereszti the highest plus variant is in the 61—65 cm group, while with Marino it is in the 66—70 cm group. These individual will be selected for seed parents as individuals of maximum value in the populations. We can see, however, that when sown at a later time, plus variants of much higher value may occur as a consequence of weather. These plus variants cannot, however, be used by the breeder for he closed the performance of mother plants with the earliest sowing. Thus, weather is to blame that the breeder cannot exploit the potentials involved in the varieties (populations)

and — against his intention — limits the success of his own work. This disadvantage can be avoided only by arranging the populations in an ecological sequence, thus evoking — with the influence of different weather conditions — the potentialities of the basic material. With this method not only maximum performance but also a wide range of ecological resistance can be provided.

On the basis of the example of red clover varieties the new ecological breeding method can be outlined as follows (Fig. 4): A self pollinating plant, e.g. poppy and the respective sowing dates were chosen as specimen. The basic material was arranged in a sequence with 6 sowing dates; plus variants were selected and blended into a "mother plant mixture". In the second year the seed of the mother plant mixture (Ak) is sown again in ecological succession and plus variants are selected from these plots too. The seed blend of these plants can already be propagated. With cross pollinating plants the same method of selection is used once again in the third year and the seed blend of these plants will be propagated.

With this new ecological breeding method three important aims are achieved: 1. possibilities of populations are fully exploited (through the influence of various weather conditions), 2. genetic factors of ecological resistance are widely maintained, 3. breeding work is accelerated and made more reliable. In addition, better results will certainly be obtained by this method in comparison with the traditional ones.

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Prepared at the National Institute of Agrobotany, Tápiószele.

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REFERENCES

MÁNDY, GY. (1963): Ecological and practical relations of the fluctuation in the values of phenological phenomena. Acta Botanica Acad. Sci. Hung., **9/1—2,** 95—103.

MÁNDY, GY. (1966): Zusammenhang zwischen Entwicklung, morphologischen Ertragselementen der Kulturpflanzen und den klimatischen Faktoren. Tagungsberichte d. DAL (Berlin), Nr 82, Teil II. 93—99.

MÁNDY, GY. (1967): Genetical influence of meteorological factors in crop stands. Acta Agronomica Acad. Sci. Hung., **16,** 428—431.

ACCUMULATION OF NUTRITIVE SUBSTANCES IN THE PEAR DURING DEVELOPMENT OF THE FRUIT AND ITS HISTOLOGICAL ASPECTS

An earlier work on the organization of the inferior pistil and the fruit of the pear suggested to examine the sugar, organic acid and total nitrogen contents of the pear in different stages of the fruit development. In this respect some informations are already available on the proportions of sugar and organic acid content (BROZIK—REGIUS 1957), but the authors' aim was to carry on the investigations and to correlate them with histological aspects.

The total N content of the growing fruit was determined by the method of Kjeldahl. Quantities of 0.25 g of the fresh tissue of the developing fruit were measured into the ashing dish in three repetitions; after addition of 1 ml cc H_2SO_4 and Se catalyzer mixture the material was decomposed in a chamber for 10 hours and the further investigation was carried out as usual (VAN SLYKE—HILLER—DILLON 1942, CHIBNALL—REES—WILLIAMS 1943). Sugar was determined by oxidation method. In the properly composed sulfuric acid agent the monosaccharides were oxidized by $K_2Cr_2O_7$ into water and carbon dioxide completely and the cane

sugar up to 96—98 per cent, without any intermediary products (method of Szeberényi, cit. Szalai—Frenyó 1962). When determining the acid the pear extract was titrated with 0.1 n NaOH with phenolphthalein addition (Fehér 1963).

The first young growing fruits of 1.5—2 cm size were gathered immediately after efflorescence on 10th June; subsequent gatherings took place on 23rd June, 6th July, 4th August, 2nd and 21st September. At the last date the fruits were already ripe. Manual sections and serial ones embedded in paraffin were made for microscopical examination and some characteristic conditions were photographed in the microscope.

The torus, that is the dense, pulpy part of the flower, including the ovary, during the inflorescence consists of thin-walled parenchyma cells; coloured cell sap can be seen in

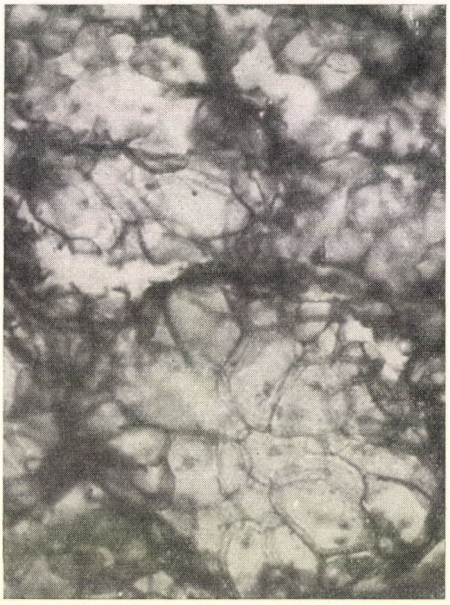

Fig. 1. Mesocarp of young fruit with sclerenchyma groups (Oc. 10×, obj. 50×)

Fig. 2. Tissue of ripe fruit with thin-walled sclerenchyma groups (Oc. 10×, obj. 50×)

some cells near the outer epidermis. 2—3 days after the inflorescence, when the petals and the stamina fell down, at first only one cell, and later radially more cells around it have their wall gradually thickened and a sclerenchyma group is developing; subsequently further sclerenchyma groups are developing in large number and are sited very closely to one another being separated by a thin-walled parenchyma of a few cells width. While the fruit is growing, the parenchyma cells remain thin and get intensely elongated in every direction further thickening of cell wall takes place and more and more sclerenchyma groups are formed. By the time the fruit reaches its largest size its very hard and compact substance is based upon the group structure of the sclerenchyma. The next step is a softening-ripening process, in what the cell walls of the sclerenchyma groups begin to dissolve. This process takes place within a sclerenchyma group from outside towards the inside. The wall of the peripheral cells gets thinner and occasionally the centrally sited sclerenchyma also loses its thick secondary wall; there are cases, however, when this central cell all the time maintains its sclerenchymatous character. The softening of sclerenchyma groups takes place of the latest around the ovary, and often these groups remain definitely in the form of a thin layer.

As shown by the chemical results the value of total nitrogen content was 2.94 mg/g, that of total acid 6.70 and that of total sugar 43.50 mg/g after the inflorescence. During the development of the fruit the total N content decreases to as small as 0.32 mg/g and increases to 1.12 mg/g at the time of ripening and softening.

As concerning the total acid content a gradual decrease takes place, and its final value will be 1.00 mg/g in ripe condition.

The total sugar amount increases up to 81.00 mg/g before the beginning of ripening, while during the ripening period its value decreases to 63.49 mg/g.

Expressed in mg/g the quantitative values of total nitrogen, organic acid and sugar contents during carpogenesis are presented in the following table:

Examined material in mg/g	Date of gathering					
	10. VI.	23. VI.	6. VII.	4. VIII.	2. IX.	21. IX.
Total N	2.94	1.64	0.32	0.38	0.48	1.12
Total acid	6.70	4.15	4.03	2.68	1.70	1.00
Total sugar	43.50	59.75	56.00	62.25	81.00	63.49

We should like to direct the attention to the conditions of quantitative development of total N content. During the fruit development the bulk of the fruit consists of sclerenchyma groups separated from one another by thin parenchyma bridges. While the sclerenchyma groups are formed, the wall of the cells composing the sclerenchyma gets intensively thickened, secondary cell wall substances are being deposited, the vacuole of the cells considerably decreases in size, leading to a similar decrease of the original plasma volume and of the vacuolar substances respectively. The decrease of total N content may be correlated with this process. An opposite one takes place during ripening, when the cell walls of the sclerenchyma groups get thinner, the volume of the plasma and the vacuoles larger — and this is suggested to manifest itself in chemical values, precisely in the quantitative increase of total N.

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*

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REFERENCES

Brozik, S.—Regius, J. (1957): Almástermésűek — Pomaceae (Pomiferous plants — Pomaceae). Mezőgazdasági Kiadó, Budapest.

Chibnall, A. C.—Rees, M. W.—Williams, E. F. (1943): The total nitrogen content of egg albumin and other proteins. Biochem. J., **37**, 354.

Fejér, D. (1963): Biokémiai gyakorlatok (Experiences in biochemistry). Egyetemi jegyzet, Budapest.

Szalai, I.—Frenyó, V. (1963): Növénytani praktikum II., Növényélettani kísérletek (Botanical practices II., Experiments on plant physiology). Tankönyvkiadó, Budapest.

Van Slyke, D. D.—Hiller, A.—Dillon, R. T. (1942): Solubilities and compositions of the phospho-12-tungstates of diamino acids and of proline, glycine and tryptophane. Biol. Chem., **146**, 137.

MODIFICATION OF VEGETATIVE DEVELOPMENT, FLOWERING AND FRUITING OF BROAD BEAN BY N-DIMETHYL-AMINO-SUCCINIC-ACID (B-995)

In the 1950s new types of chemicals were shown to reduce the growth of higher plants. These compounds, different in their chemical structure, generally have quite similar effects on plants. They inhibit growth without evoking severe morphological abnormalities.

Though B-995 (N-dimethyl-amino-succinic-acid) is one of the most important among these compounds, its mode of action is not fully understood yet. So this chemical was used in the present investigations in an attempt to elucidate its action on plants.

The present paper contains the results of B-995 applied in different concentrations. All experiments were run with broad bean (*Vicia faba* var. Rabaya 34) and the B-995 solution was applied during the soaking, or in the form of fine spray on young plants.

The results of the experiments are summarized in tables and figures.

Broad bean plants, treated with B-995 can be characterized by a marked suppression of stem elongation and a small stimulation of root length (Table 1). The reduction in stem height can be accounted for a restriction of the extension of internodes which were short and thick. The dry and organic matter content in treated plants consequently decreased in leaves and stem, but not in roots. The ash content was not subject to any change (Table 2).

The developed leaves of treated plants were deep-greener in colour than those of untreated plants.

Table 1

The effect of B-995 on broad bean plants
(B-995 was applied during soaking)

Treatment	Height of shoot, cm	Root length, cm
Control	20.93	26.83
100 ppm	19.55	27.63
250 ppm	18.03	28.10

Table 2

The effect of B-995 on the percentage of dry and organic matter, and ash content of leaves, stems and roots of broad bean plants, three weeks after sowing
Applied during soaking

Treatment	Dry matter content %			Organic matter content %			Ash content %		
	leaf	stem	root	leaf	stem	root	leaf	stem	root
Control	12.9	8.8	6.7	11.09	8.06	5.18	1.00	0.74	1.54
100 ppm	10.5	7.7	5.4	9.55	7.08	3.97	0.93	0.63	1.45
250 ppm	8.3	7.7	5.7	7.46	7.06	4.22	0.87	0.63	1.47

All plants from seeds, soaked either in water or in B-995 flowered on the same day, but the number of flowers on plants treated with B-995 was greater than on water-treated controls (Fig. 1).

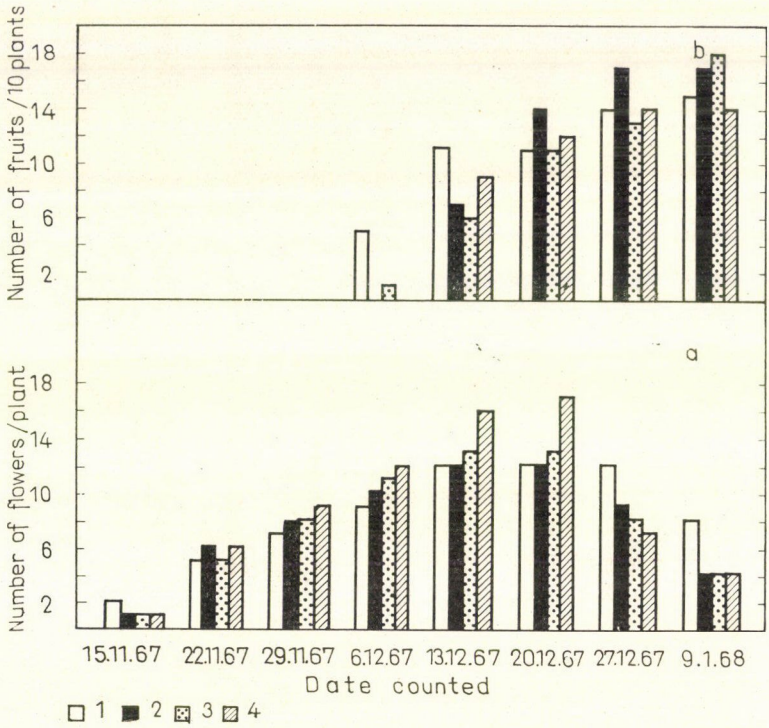

Fig. 1. Effect of B-995 on the number of flowers (a) and fruits (b) of broad bean plants. 1 = water-soaked control; 2 = soaked in 100 ppm of B-995; 3 = soaked in 250 ppm of B-995; 4 = soaked in 500 ppm of B-995

-995 was applied during soaking. Flowering and fruiting measures throughout the 86-day experimental period were recorded

Spraying, again, proved to be a better method of applying B-995 than soaking the seeds, since more flowers and fruits were developed on the sprayed plants (Fig. 2). The greatest number of flowers and fruits were persistent on 100 ppm of B-995 sprayed plants. The 100 and 250 ppm of B-995 proved to be better than 500 ppm with respect to yield.

All physiological effects of B-995 were depending on its concentration.

On the basis of the presented data it can be concluded that B-995, without decreasing the number of flowers or the yield, has a growth-retarding effect on broad bean. This effect of B-995 may be used in the practice too.

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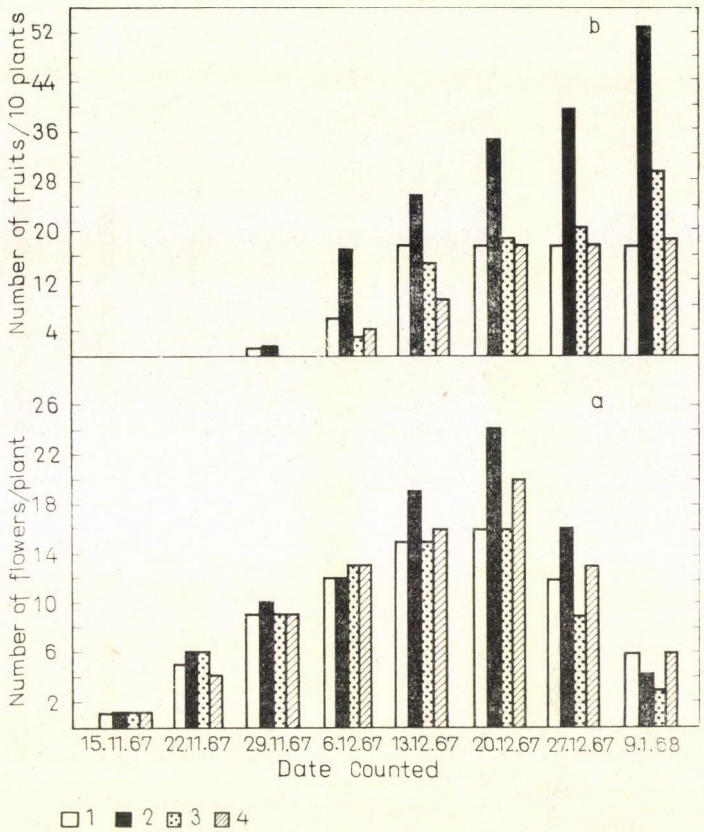

Fig. 2. Effect of B-995 on the number of flowers (a) and fruits (b) of broad bean plants. 1 = water-sprayed control. 2 = sprayed with 100 ppm of B-995. 3 = sprayed with 250 ppm of B-995. 4 = sprayed with 500 ppm of B-995. The B-995 in form of fine spray was applied at the 14nd, 28th, 35nd, and 42th days after sowing. Flowering and fruiting measures throughout the 86-day experimental period were recorded

PATH ANALYSIS OF WHEAT GRAIN YIELDS

Path analysis is a new method of studying relationships between plant characteristics. This method has been used so far by DEWEY—LU (1959) in studying the nature of the crop of the crested wheatgrass, then by FONSECA—PATTERSON (1968) in investigating direct and indirect relations between yield components and earliness as well as plant heights of winter wheats.

FONSECA—PATTERSON (1968) found that the number of productive ears and that of the grains had a considerable direct effect on the yield of the plant, while thousand-grain-weights influenced it only to a low extent. Earliness and plant height did not show any considerable direct effects. Whith the method of path analysis used, however, it was found that earliness had a remarkable negative influence on the number of grains, thus, indirectly on yields.

In our own experiments relationships between yield components were studied in the winter wheat varieties Besostaya 1 and Fertődi 293, as well as in the random hybrid population of the F_3 generation of Besostaya 1 × Fertődi 293. The experiment was set in six replications, in densely sown plots of 5 m² each, in 1965. 30 plants were collected and tested from each plot. Path analysis was carried out with the method suggested by DEWEY—LU (1959).

Path values of Besostaya 1 (Fig. 1) showed that productive stooling had a considerable direct effect on grain yield. Grain weight per main ear had less influence on the yield. Other (unknown) factors had no significant influence at all. There was a moderately close positive

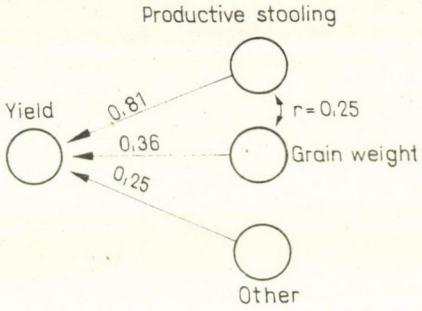

Fig. 1. Path coefficients of Besostaya 1 (1964—65)

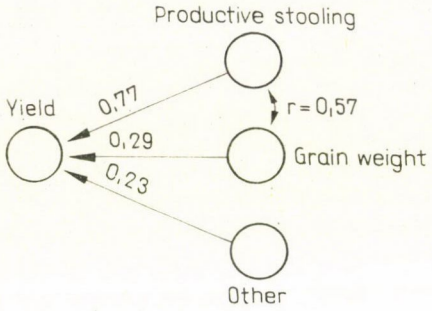

Fig. 2. Path coefficients of Fertődi 293 (1964—65)

correlation between productive tillering and grain weight per main ear. This suggests that the number of ears had a considerable indirect effect on the yield.

It was also productive stooling that had a high direct effect on the yield trends of the variety Fertődi 293 (Fig. 2). Path value was higher here than it was in the variety Besostaya 1. Grain weight too influenced the yield of Fertődi 293 to a higher extent than that of the variety Besostaya 1. As to other factors, the reactions of the two varieties were the same. Correlation coefficient between grain weight and productive stooling showed a very low indirect effect.

Direct effect on grain yield of productive stooling in the hybrid population of Besostaya 1 × Fertődi 293 was similar to that observed in the variety Besostaya 1 (Fig. 3). Path coefficient between yield and grain weight was, however, higher than that of the parents. Thus, grain weight per ear had a greater influence on grain yield per plant in hybrids than in the parents. Other factors did not play any important role in this case. Interaction between productive

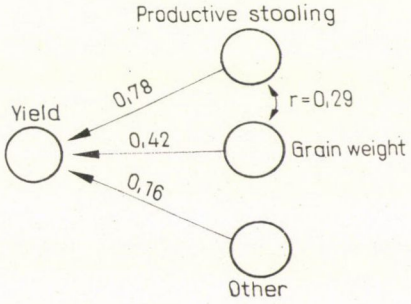

Fig. 3. Path coefficients of Besostaya 1 × Fertődi 293 F_3 (1964—65)

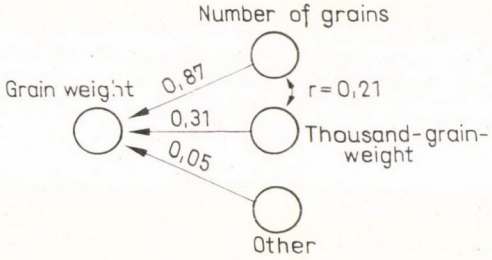

Fig. 4. Path coefficients of Besostaya 1 (1964—65)

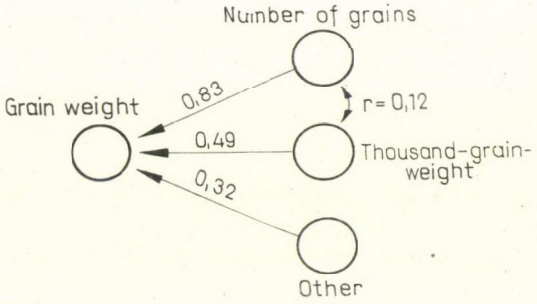

Fig. 5. Path coefficients of Fertődi 293 (1964—65)

stooling and grain weight was very slight, similar to that in the variety Fertődi 293. Thus, indirect effect was not significant.

Further analysis of relations between yield components showed that grain number had a high while thousand-grain-weight a low direct effect on grain weight in Besostaya 1 (Fig. 4). Correlation coefficient of grain number and thousand-grain-weight suggests a loose correlation between the two factors. Thus the indirect effect of these characteristics is also low. Other factors had but a slight influence on the grain weight.

The number of grains influenced the grain weight in the variety Fertődi 293 and the Besostaya 1 × Fertődi 293 hybrid population (Figs 5 and 6) in a similar way as in the case of the variety Besostaya 1. The effect of thousand-grain-weight is, however, higher. Correlation coefficient between grain number and thousand-grain-weight is very low, does not indicate any indirect influence.

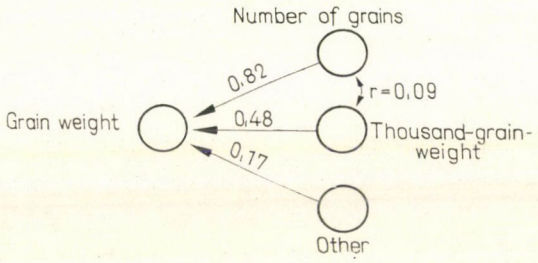

Fig. 6. Path coefficients of Besostaya 1 × Fertődi 293 F_3 (1964–65)

The other factors had a relatively high effect on grain weight in the variety Fertődi 293. In the hybrid population this effect was intermediate between the two parents.

Data on the high effects of productive ear and grain number and low effect of thousand-grain-weight agree with FONSECA—PATTERSON's findings (1968). Our data suggest, however, that these effects are not the same in all varieties. Indirect interactions between characteristics may also be different in various populations.

Acknowledgement

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REFERENCES

DEWEY, D. R.—LU, K. H. (1959): A correlation and path coefficient analysis of components of crested wheatgrass seed production. Agron. J., **51**, 1–10.

FONSECA, S.—PATTERSON, F. L. (1968): Yield component heritabilities and interrelationships in winter wheat *(Triticum aestivum)*. Crop Sci., **8**, 614–617.

THE RESPONSE OF PHYSIO-PATHOLOGICALLY CHANGED MILK TO THE ALKALINE PHOSPHATASE TEST

It was WAGNER (1965) who dealt with the possibility of applying the quick phosphatase test in the field of the hygiene and technology of milk industry, however, no data are submitted regarding the milk-sorts changed physiologically (fresh and old milking), and pathologically (garget). Since no data are available regarding the alkaline phosphatase test, it has been found necessary to carry out such kinds of tests. KOVALSKY—SUMKOVA (1963) have established that the enzyme activity of the dry-stagnant udder tissue is higher than that of the functioning tissue since in the course of milk separation a considerable part of the enzymes goes over to the milk. This latter fact refers to a greater degree to milks changed physiologically and pathologically, since due to cell-decomposition and the infiltration of cellular elements, an increase in the enzyme activity can be expected. SCHÖNHERR (1965) refers to the fact that in secretion or in the milk obtained in the case of garget, the activity of aldehyde reductase, catalase

and diastase considerably increases, however, he does not refer to the alkaline phosphatase test. According to BUCK (1942), in the course of the investigations the fact that the test might be affected also by phosphatase positive bacteria has to be taken into account. TOLNAY (1963) has established, after a two-hour incubation of the material, that all the original alkaline phosphatase enzymes can be observed. Due to the presence of phosphatase positive bacteria, it is necessary to complement the tests also with bacteriological examinations for which HALLMANN'S (1961) method is the most suitable.

For the investigations 1 g free phenolphthalein—free phenolphthalein phosphate, 4 g potassium hydroxide, 36 g substrate buffer solution containing potassium hydrogen carbonate of crystal water content had been used in 1000 ml aqueous solution. From this 2 ml was fed into a test-tube and then 2 ml of the substance to be examined was added. After the time of incubation had elapsed 10 drops of normal sodium hydroxide were added. In the positive case the test showed carmine red or pink colour reaction. In negative case it remained white. For the investigations the following material has been used:

1. raw milk,
2. milk heated to 72°C, to 85°C and to 92°C,
3. milk heated to 72°C that had been treated with 0.1 per cent colostrum and old milk, respectively, gained directly before it gets dry, as well as 4+, 3+, 2+ and 1+ Whiteside and Schalm positive-reaction milk, further,
4. milk heated to 72°C that had been treated with 0.1, 0.3 per cent raw milk and 3+, 2+, and 1+ Whiteside and Schalm positive-reaction milk, respectively.

The investigations have been complemented with paper-strip test and bacteriological examination. The bacteriological examinations were necessary because the presence of the phosphatase positive bacteria might increase the sensibility of the test. The examination was as follows:

Of the samples obtained decimal dilutions were made and of these 1 ml each had been poured into sterile Petri dishes and afterwards 2 ml sterile neutral 10 per cent sodium-phenolphthalein phosphate containing no free phenolphthalein and Polonyi milky agar were added. The Petri dishes were then placed into a 37°C thermostat for 24 hours. After 24 hours, the open Petri dishes were kept above 10 per cent ammonium hydroxide under the effect of which the deposits of the phosphatase-positive bacteria became carmine red from the free phenolphthalein. For the paper-strip test Whatman No. I filter paper was used that had been soaked with phosphatase reagent and dried at 37°C. In the course of the investigations the tube tests were incubated in a 37°C thermostat for 10 minutes, 1 hour, 2 hours and for a 24-hour period, respectively.

The paper-strip tests were incubated under the same circumstances, but without the 24-hour examination. The latter has been omitted due to the fact that the paper-strips got coloured even in the case of negative bacteriological results. In order to get the accuracy needed, the investigations were performed with 3 samples each.

From the data of Table 1 it can be established that from the point of view of alkaline phosphatase, it is primarily the fore-milk (colostrum) and, secondly, milks of very strong Whiteside and Schalm positive reaction, that are of importance. If, in the pasteurized mixed-milk such raw milk is present in 0.1 per cent, it can be proved with a 10-minute quick phosphatase test. This is important because it is well-known that otherwise in the pasteurized milk-mixture only 1—2 per cent raw milk can be observed. After a 2-hour incubation period the phosphatase positive bacteria have no positive influence on the results, since in the case of test-tube tests all the original enzymes can be obtained within 2 hours. The number of phosphatase positive bacteria was so low that it did not influence the result of the investigations. The phosphatase positive bacteria have to be present in the test material in 10^6—10^7 order of magnitude so as to obtain positive results within 2 hours. After a 24-hour incubation positive

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Table 1

Results obtained from the comparative examinations of the phosphatase test

Denomination of the sample	Phosphatase positive bacteria/ml	Tube test				Paper-strip test		
		10 min	1 hour	2 hours	24 hours	10 min	1 hour	2 hours
Raw milk	10^2—10^3	+++	+++	++++	++++	++	+++	++++
Milk heated to 72°C	0—10^1	—	—	—	— +	—	—	—
Milk heated to 85°C	0—10^0	—	—	—	— +	—	—	—
Milk heated to 92°C	0—10^1	—	—	—	— +	—	—	—
Heated milk + 0.1 per cent colostrum	10^0—10^1	+	++	++++	++++	—	+	+++
Heated milk +0.1 per cent old-milking milk	0—10^0	+	++	++++	++++	—	+	+++
Heated milk + 0.1 per cent ++++ milk	10^2—10^3	±	++	++++	++++	—	—	+++
Heated milk + 0.1 per cent +++ milk	10^1—10^2	—	+	++	++++	—	—	+
Heated milk + 0.1 per cent ++ milk	10^0—10^1	—	—	+	++++	—	—	—
Heated milk + 0.1 per cent + milk	10^1—10^2	—	—	+	++++	—	—	—
Heated milk + 0.1 per cent raw milk	10^0—10^1	—	—	+	++++	—	—	—
Heated milk + 0.3 per cent raw milk	10^2—10^3	—	—	+	++++	—	—	—
Heated milk + 1 per cent raw milk	10^2—10^3	±	++	+++	++++	—	+	++
Heated milk + 1 per cent +++ milk	10^2—10^3	+	+++	++++	++++	—	++	+++
Heated milk + 1 per cent ++ milk	10^1—10^2	+	+++	++++	++++	—	++	+++
Heated milk + 1 per cent + milk	10^0—10^1	±	+++	++++	++++	—	++	+++

++++ very strong reaction
+++ strong reaction
++ explicit reaction
+ weak reaction
± very weak reaction
— negative reaction

result showed itself in all those samples the test material of which contained phosphatase positive bacteria.

On the basis of examinations referring to the sensitivity of the phosphatase test, it has been established that from the point of view of the increase in sensitivity, it is partly the colostrum, the old-milking milk obtained right before drying, partly the very highly Whiteside and Schalm positive garget-milk that are of great importance. If in the milk-mixture the quantity of such milk is but 0.1 per cent, this would increase the sensibility of the test.

Acknowledgement

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*

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REFERENCES

BUCK, T. C. Jr. (1942): False positive phosphatase test from thermophil in pasteurized milk. Am. J. Publ. Health, **32**, 1224—1236.

HALLMANN, L. (1961): Bakteriologie und Serologie. G. Thieme Verl., Stuttgart. 775—898.

KOVALSKY, V. V.—SUMKOVA, I. A.—Ковалский, В. В. — Шумкова, И. А. (1963): Адаптивные изменения ферментов молочной железы коров. Доклады А. Н. СССР, **152**, 1243—1246.

SCHÖNHERR, W. (1965): Tierärztliche Milchuntersuchung. S. Hirzel Verlag, Leipzig. 22.

TOLNAY, B. (1963): Ipari enzimologia (Industrial Enzymology). Műszaki Kiadó, Budapest. 383.

WAGNER, A. (1965): A gyorsfoszfatáze próba alkalmazási lehetőségei és értékelése az ipari higiene és a technológia területén (The possibility of applying the quick phosphatase test and its valuation in the field of industrial hygiene and technology). Tejipar, **14**, 52—54.

SOME OBSERVATIONS CONCERNING THE DEVELOPMENT OF THE APPLE FRUIT

There is a rather vexed question connected with the development of both the inferior pistil and fruit of the apple: whether they sink into the torus or grow together with the other floral leaves or, at least both regions (the torus and the other floral leaves) participate in the formation of the pistils and the fruits respectively. According to the initial investigations (TREVIRANUS 1838, DECAISNE 1857, SCHACHT 1859, KARSTEN 1865) the pistil and later the fruit gets organized axially sinking into the torus. The examination of the vascular bundle system directed the attention to the participation of the floral leaves in the organization of the pistil and that of the fruit, i.e. to their appendicular character (VAN TIEGHEM 1867, VELENOVSKY 1904). In the first half of the century some authors revived the axial theory and their investigations stressed the fact of the pistil sinking into the torus (TROLL 1931, WETTSTEIN 1933). Subsequently on the basis of minute morphological and histological observations the conclusion was that the accrete below part of the tissue regions of the sepals, petals and the stamen-leaves participates in the formation of the fruit (MAC DANIELS 1940, EAMES—MAC DANIELS 1947, KURSZANOV *et al.* 1952, TAKHTAJAN 1959, ROBBINS—WEIER—STOCKING 1965).

On the basis of these conflicting literary data and that of the ramifications of the vascular bundle system not known up till now and observed during our investigations in the last few years the idea presented itself to deal exhaustively with the developmental conditions of the vascular bundle system starting from the pistil up to the state of the completely developed fruit, with the aim of finding out in what degree the torus and flower-leaves participate in their formation.

Our investigations were performed on the Jonathan variety of the garden apple tree (*Malus pumila* L.) by the aid of partly hand-made and partly microtomic sections. Besides some hand-made longitudinal and cross sections of older fruits were dried on glass-plates for 2—3 days. In this manner the vascular bundles become more distinct and when dyed, they become even more visible.

At first we analysed morphologically the dividing line between the torus and the origin of the flower leaves. The nodal level, having a decisive importance when determining the real or apparent character of the inferior pistil on the flower of the *Foeniculum vulgare* (SÁRKÁNY 1962) and the *Helianthus annus* (GRACZA 1966) respectively, cannot be discernible even by an exhaustive examination on the flower of the apple. The comose sepals join the torus without any dividing line and the hirsuteness can be found without a break on the peduncle of the flower too. The zone of contact of the torus and the flower-leaves cannot be distinguished either on the longitudinal section of the flower. The reversely egg-shaped white or slightly coloured petals grow alternately as compared to the sepals and take their origin abreast of the calyces, well over the ovarian part. The twenty stamina are starting from here too. The style-part of the pistils over the starting level of the other flower-leaves is of apocarpic, whereas the ovary-part may be of cenocarpic character downwards too.

Within the frames of our histological investigations at first we give a short report on the histological structure of the so called "torus" including the wall of the ovary. Under the epidermis, consisting of one single layer of cells 4—5 layers of cells have considerably thicker cell walls. Towards the interior in the parenchymal tissue, extending as far as the ovarian cavities, run the vascular bundles (calyx, petal). According to our observations it is characteristic of this parenchymal tissue that in the regions outside of the vascular bundles the cells are elongated rather in the direction of the epidermis (i.e. horizontally) while on the inner part parallelly with the ovarian cavity (i.e. vertically). This fact may be looked at in the sense that the outer region of the parenchymal tissue is of toral origin, while the inner part consists of the tissue-region of the flower-leaves grown together congenitally, although this interpretation cannot be proved satisfactorily. The above mentioned feature may also be explained by assuming that the external part of the parenchyma promotes the growth in width by the extension of the cells, whereas the longitudinal growth of the toric part is the result of the extension of the inner region (Fig. 1).

Passing over to the tissue systems of the vascular bundles of the floral torus we have to mention that the latest and very detailed results on this matter were published by MAC DANIELS (1940), EAMES—MAC DANIELS (1947) and on the basis of their investigations by ROBBINS—WEIER—STOCKING (1965). By reason of these investigations concerned with the system of vascular tissues they qualify the formation of both the pistil and the fruit as a result of appendicular organization.

We have started our investigations concerning the developmental conditions, of the vascular tissue system in the flower stage (Fig. 1 A, A_1; B, B_1). In the cross-section made of the floral peduncle there are 6—7 bundles situated along a circle. At a somewhat higher level under the floral torus several smaller bundles (ti) branch off from the peduncular bundles (pe) outwards and 5 ones of medium size inwards. The latter are the ventral bundles of the pistil (vc). The so called "peduncular bundles", running in the middle circle of the vascular bundles of the toral part, bend outwards below the pistil region and bifurcate transversally. Further

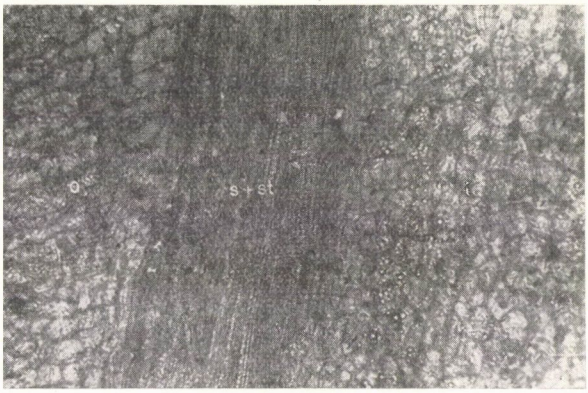

Fig. 1. Longitudinal section of the "toral" part of the *Malus pumila* L. In the middle the common bundle (s + st) of the sepal and the stamen may be seen. Outward of it the cells are lengthened at right angles to the vascular bundles (according to our supposition the tissue region of the torus); inwards (I) the cells are stretched parallelly with the vascular bundles

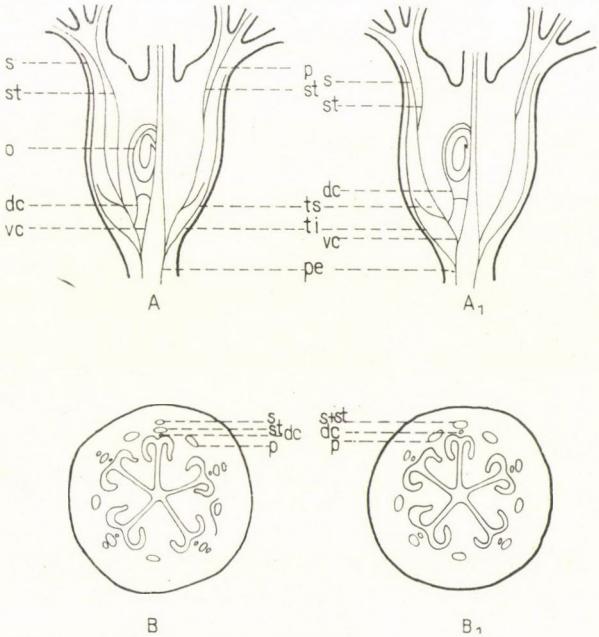

Fig. 2. Longitudinal section (A, A_1) and cross section (B, B_1) of the toral part of the flower of *Malus pumila* L. The calycinal bundles part off below the pistil from the stamen bundles (A) and this may be observed in the cross-section too (B). In another case the calycinal and staminal bundles branch off only above the ovarian part of the pistil (A_1, B_1). The toral bundles (ti, ts) may be discerned well in the section plane; s = sepal bundle; st = staminal bundle; p = petal bundle; dc = dorsal bundle of the pistil; vc = ventral bundle of the pistil; ts = the upper bundles of the torus; ti = lower bundles of the torus; s + st = common bundle of the sepal and the stamen; o = ovary

on we describe the developmental conditions of the vascular bundles. Out of each of the 10 bundles, formed in the above mentioned way still in the zone below the pistil, one bundle (ts) starts in the direction of the peripheral part covering with a network the tissue under the epidermis and joining the thin peripheral bundles coming from below. Among the 10 bundles running upwards, on the inner side of each of the five ones situated in the direction of the monomer ovaries, a bundle branches off and running on the outer side of the ovary grows around it (the dorsal bundle of the pistil, dc). At a somewhat higher level, mostly under

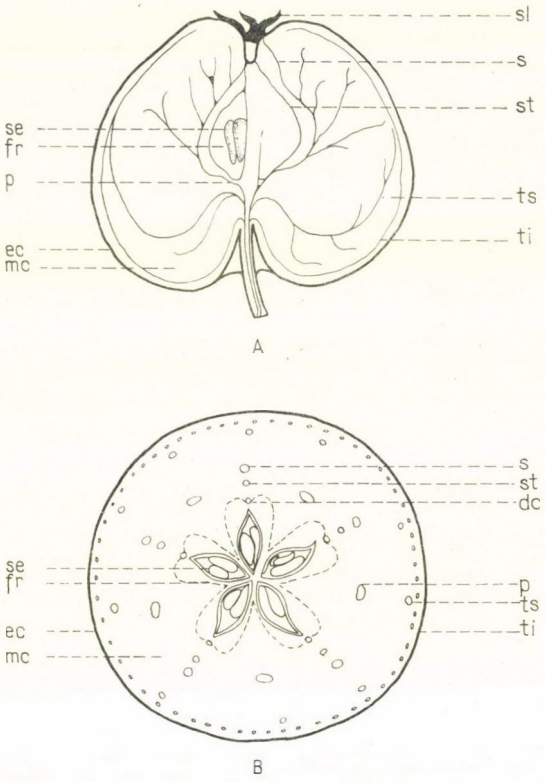

Fig. 3. Longitudinal and cross section of the fruit of *Malus pumila* L. (A, B); s = sepal bundle st = staminal bundle; p = petal bundle; fr = follicle; se = seed; ti = lower toral bundles; ts = upper toral bundles; ec = endocarp; mc = mesocarp; dc = dorsal bundle of fruit; sl = sepal

the pistil (A), but sometimes above the pistil (A_1) we may observe a new branching off: the sepaline and the staminal bundles dispart, namely the inner staminal and the outer sepaline bundles. Among the ten bundles under the pistil region each of the remaining five bundles runs upwards in alternating positions and they pull apart in a superposed position into separate petaline- and staminal-bundles. The latter ones dispart once more in the upper part of the torus immediately before entering the staminal filaments. The peripheral bundles separating off, partly at the subtoral level and partly in the lower part of the torus, into the peripheral part, according to our supposition may be looked upon as toral bundles and on

this basis the periovarian part of the region of the floral body called "torus" is formed by the calycinal and staminal tissues congenitally grown together, whereas its outer peripheral part is formed by the toral tissues.

Further on our investigations concerning the full-grown apple-fruit are dealt with (Figs 3, 4). We began making by hand sections in the direction of the sepals (sl) remaining on the upper side of the fruit. The course of the bundles may be followed up well even with the naked eye. The ready sections were put on a glass-plate and allowed to dry for some days. In this way the vascular bundles became even more distinct. The peduncle of the fruit sinks deeply into the lower, peripheral part of the fruit, which has thickened very significantly. The follicles (fr) together with the mature seeds (se) are situated in the direction of the sepals.

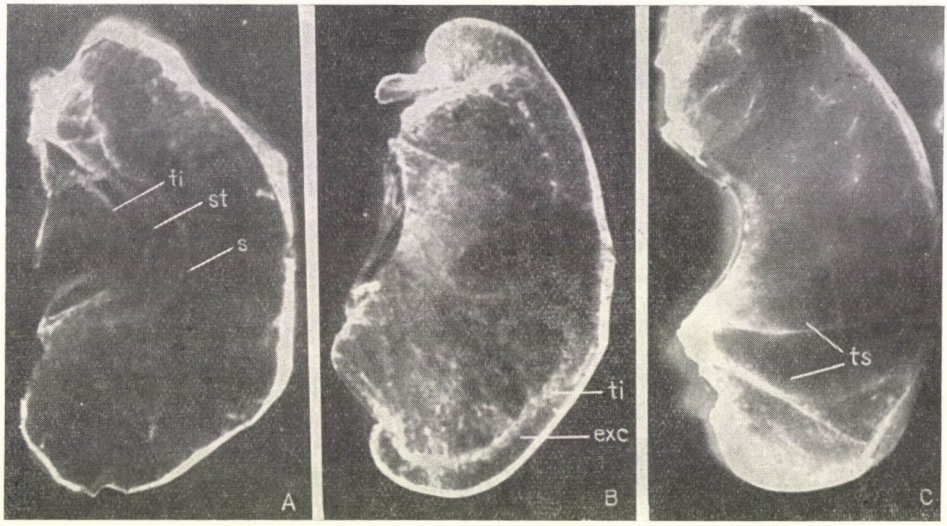

Fig. 4. Malus pumila L. — Some details of the fruit-wall. A) The sepaline bundle runs separate ly from the staminal one (st); B) The lower toral bundle (ti) runs immediately under the exocarp (exc) upwards; C) The upper bundles of the torus (ts) bend out to the side and then turning upwards close to the exocarp they run further on upwards in the fruit

Starting from the peduncle of the fruit there are three bundles running on the outer side of the follicle. The inner, smaller one is the dorsal bundle of the fruit (dc), the middle one is the staminal bundle (st) and the outer one is the calyx-bundle (s) which drawing away even more off the stamina in the upper part of the fleshy apple fruit joins into the sepal making a large bend.

Between the two follicles only one bundle runs upwards (p) out of the lower part of the apple fruit starting from the fruit-peduncle. This is the common bundle of the stamen and the petal, which part asunder only above the follicular fruit forming the external petal and the internal stamen bundles.

There is a lot of small bundles running on the peripheral part of the fleshy apple fruit, immediately under the exocarp, which have branched off from the fruit-peduncle. Above these bundles the peripheral ones (ti) originating in the lower part of the torus are to be found. Having substantially increased they show a diameter almost identical with that of the calycinal

bundles. The former ones run at first somewhat downwards and then, bending in a bow, upwards anastomosing in some cases with the peripheral bundles coming from below and covering with a network the outer tissue as far as the upper part of the fruit (ts).

These peripheral bundles branching off at two levels, branch off in the case of both the flowers and the fruits below the bundles of the floral leaves (calyx, petal, stamen). They may be taken, according to our supposition, for toral bundles and therefore the peripheral tissue region may be qualified as of toral origin. Thus the mesocarp (mc) of the fleshy apple fruit is built up of the outer tissue region of toral origin extending almost to the upper part of the fruit and of the zone of the inner floral leaves grown together below. Consequently both the axial and the appendicular characters manifest themselves in the formation of the fruit.

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REFERENCES

Decaisne, J. (1857): Note sur l'organogénie floral du poirier. Bull. Soc. Bot., **4,** 338—342.

Eames, A. J.—Mac Daniels, L. H. (1947): An introduction to plant anatomy. McGraw-Hill Publishing Company, New York, London, Toronto.

Gracza, P. (1966): Organisationsverhältnisse des Gynäzeums der Sonnenblume. Annales Univ. Sci. Budapestiensis de Rol. Eötvös Nom., **8,** 97—105.

Karsten, H. (1865): Gesammelte Beiträge zur Anatomie und Physiologie der Pflanzen. **1,** 345. Dümmler Verlag, Berlin.

Kurszanov, L. I.—Komarnickij, N. A.—Mejer, K. I.—Razdorszkij, V. F.—Uranov, A. A. (1952): Botanika. Botany I. Plant anatomy and plant morphology. Mezőgazdasági Kiadó, Budapest.

Mac Daniels, L. H. (1940): The morphology of the apple and other pome fruits. Cornell Univ. Agr. Exp. Sta. Mem., 230.

Robbins, W. W.—Weier, T. E.—Stocking, C. R. (1965): Botany an introduction to plant science. John Wiley and Sons, Inc., New York, London, Sydney.

Schacht, H. (1859): Lehrbuch der Anatomie und Physiologie der Gewächse. G.W.F. Müller Verlag, Berlin.

Sárkány, S. (1962): Organisation des Stempels und der Spaltfrucht von *Foeniculum vulgare* Mill. und die Frage des sogenannten unterständigen Fruchtknotens. Ann. Univ. Sci. Budapestiensis de Rol. Eötvös Nom., **5,** 193—224.

Takhtajan, A. (1959): Die Evolution der Angiospermen. G. Fischer Verlag, Jena.

Treviranus, W. (1838): Physiologie der Gewächse. **2,** A. Marcus Verlag, Bonn.

Troll, W. (1931): Beiträge zur Morphologie des Gynaeceums. Planta, **14,** 1—18.

Van Tieghem, P. (1879): Anatomie de la rose en général charactères anatomique des axes invaginés. Bull. Soc. Bot. France, **25,** 309—315.

Velenovszky, J. (1904): Die gegliederten Blüthen. Bot. Gentbl. Beihefte, **16,** 289—300.

Wettstein, R. (1933—1935): Handbuch der Systemat. Botanik. Deutscher Verlag, Wien.

WINTER WHEAT FLEISCHMANN 481

Taxonomical position: Triticum aestivum L. var. *erythrospermum* (KÖRN.) MSF.

Origin: Ruma 244×Székács 1×Kanred selected from a regional variety.

Beginning of breeding: Ruma 1909, Kompolt 1918.

Breeder: †FLEISCHMANN, R. dr. (Kompolt); variety maintained by the Agricultural Research Institute, Kompolt.

State qualification: State registered improved variety 1928, 1951.

General characterization: Winter-hardy, drought resistant, medium early, red grained, bearded winter wheat of reliable and high productivity and good flour quality, susceptible to lodging, tolerant to extreme conditions; ripening is not uniform due to secondary ears.

Morphological description:

Root system: penetrates into the soil to a depth of about 110 cm; 65 per cent of the roots is found in the upper 10 cm of the cultivated soil layer and only 19 per cent in the 20 cm layer below (KÁRPÁTI—MÁNDY 1961).

Shoot system: growth and tillering vigorous. The extent of tillering is 2.5—3.3.

Culm: 107.5 cm on the average (range: 88—117 cm), thin, fine, susceptible to lodging, still non-rigid; colour is yellowish-white when mature. Length of internodes (from the base upwards) is an average of 3.4, 9.4, 12.7, 18.7, 30.4, 34.6 cm (BAJAI 1961).

Foliage: Young plants have spreading, light green leaves with narrow leaf-blades. Fully developed leaves are oblong lanceolate with an average length of 26.9 cm and average leaf surface of 26 cm^2 (BAJAI 1961a). Leaf apex is sharp, auricle at the leaf base purplish red (gradually becoming white after flowering). Leaf blade is reclinate, narrow and thin, susceptible to diseases (PAPP 1954).

Ear: bearded oblongum, with an average length of 7.7 cm (range: 6.9—8.2), and yellowish white colour when ripe; compact, inclined. Spikelets are closely arranged-

on the rachis and contain normally 2—3 grains, shed hardly any grain when mature. Grain weight per ear 0.72 g (range: 0.46—1.23 g); average weight of ears 1.48 g (range: 1.35—1.60 g); average number of ears per m^2 493 (range: 348—510) when normally sown. Beard long, fine. Glumes are elliptical, tips narrow, rounded, beards are shorter than lodicules. When maturing the level of ears is not uniform owing to the great number of secondary ears; here and there ears tower above the stand.

Caryopsis: elongated ovate, 4.5—7.2 mm long and 2.4—3.6 mm wide. The embryo scutellum is round, the embryo vigorous. The grain is red (brownish), its substance hard, flinty. Thousand grain weight 34.9 g on the average (ranging from 28.7 to 39.5 g), hectolitre weight 79.4 kg (ranging between 77.8 and 81.8 kg). The quality of the flour good (B_1—A_2), wet aleuron content 28—32 per cent, dry aleuron content 9—11 per cent. The quality of flour varies with the site of growing (KAPÁS *et al.* 1965).

Biological characters:

Germination: cardinal points: minimum +2°C, optimum 15°C, maximum 35°C. Optimum germination period 4—6 days (MÁNDY 1961).

Vegetation period: from seeding to ripening 264 days on the average (ranging from 247 to 273 days).

Development: Even at a relatively low temperature germinates, grows and tillers well, thereby develops an adequate stand and gives a sufficiently high yield when sown late in the autumn. If the number of secondary ears is high, ripening is somewhat prolonged (PAPP 1954). Ripening is medium early, uneven.

Winter hardiness: Excellent.

Resistance to diseases: slight susceptibility to dust-brand; rust occurs especially in lodging (KAPÁS *et al.* 1965).

Farm technology requirements:

Seeding: is optimally medium late, in the second half of October; it gives, however, an adequate yield even when sown late (November, December) (MÁNDY 1967). Seed requirement 3—3.1 million germs/cad.yoke (520—540 germs/sq.m).

Soil requirement: yields are sufficiently high even in soils of extensive, dry nature; however, in soils rich in nutrients (nitrogen) the plants lodge. Its requirements with regard to the state of cultivation, nutrient- and water supply of the soil are not high (KAPÁS *et al.* 1965).

Productivity: Grain yield on the average of many years is 16.6 q/cad.yoke (1 cad. yoke = 5754.56 m^2 = 1422 acre) (ranging from 10.6 to 19.2 q/cad.yoke); straw yield an average of 33.2 q/cad.yoke (ranging from 22—43 q/cad.yoke).

Area of cultivation: it is best grown in the poor soils of the higher northern regions of Hungary as well as in districts where it is sown late (KAPÁS *et al.* 1965).

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Prepared at the National Institute of Agrobotany, Tápiószele

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REFERENCES

BAJAI, J. (1961): Kalászanalízisek és szalmaszártag hosszúság-mérések őszibúza-vetésmód kísérletben (Analyses of ears and measurements of the length of straw internodes in an experiment on winter wheat sowing methods). Búzatermesztési Kísérletek 1952—1959. Akadémiai Kiadó, Budapest, 147—151.

BAJAI, J. (1961a): Növekedésritmus- és levélfelület vizsgálatok őszibúza-vetésmód kísérletekben (Growth rhythm and leaf surface studies in sowing method experiments with winter wheat). Búzatermesztési Kísérletek 1952—1959. Akadémiai Kiadó, Budapest, 129—146.

KAPÁS, S. *et al.* (1965): Minősített növényfajtáink (State certified Hungarian plant varieties). Mezőgazdasági Kiadó, Budapest.

KÁRPÁTI, V.—MÁNDY, GY. (1961): Adatok nemesített búzafajtáink gyökérzetének mennyileges viszonyaihoz. (Data on the quantitative relations in the root systems of improved Hungarian wheat varieties). Búzatermesztési Kísérletek 1952—1959, Akadémiai Kiadó, Budapest, 532—547.

MÁNDY, GY. (1961): A csírázáshőmérséklet kardinális pontjainak vizsgálata hazai őszibúza fajtákkal (Investigations into the cardinal points of germination temperature in Hungarian winter wheat varieties). Búzatermesztési Kísérletek 1952—1959. Akadémiai Kiadó, Budapest, 105—109.

MÁNDY, GY. (1967): Őszi búzák fenoökológiai vizsgálata (Phenoecological studies on winter wheats). Agrobotanika, 1965. **7/2,** 29—41.

PAPP, ZS. (1954): Őszi búza (Winter wheat). Nemesített növényfajtákkal végzett országos fajtakísérletek eredményei. 1953. Mezőgazdasági Kiadó, Budapest. 133—173.

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FORUM

PRELIMINARY STUDIES TO THE EVOLUTIONARY INTERPRETATION OF PERIODICAL ONTOGENY* ("ALTERNATION OF GENERATIONS") IN PLANTS**

It is known that the ontogenesis of most living plants consists of two stages linked by nuclear phase change. The same law is valid for the animal world with the difference that in the life cycle of animals the gametic, while among the majority of plants the zygotic and intermediate nuclear phase changes prevail. As nuclear phase change plays a dominant role in the formation of new individuals and thus in the perpetuation of the genus or the category, it is obvious that the alternation of generations is a substantial driving force and form of manifestation of phylogeny. We can conceive phylogeny as consisting of an endless sequence of periodically alternating ontogenic stages. In technical literature, the ontogenic stages are,

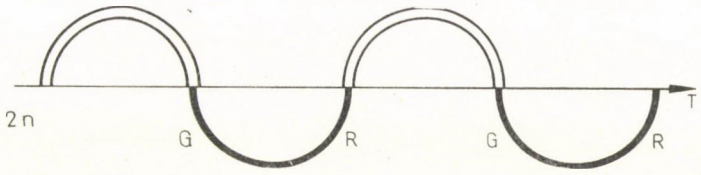

Fig. 1. Graphic representation of intermediate isomorphic ontogeny. n: haploid, 2n: diploid domain. G: gamy, R: reduction. T: time axis, at once phase boundary

for practical reasons, represented in the form of a recurring line, usually a circle. In reality, however, the entity of these stages gives a spiral since a life cycle does not recur to itself but only to a stage identical or similar in phase. The difficulties of representation can be eliminated by laying the axis of the spiral in the plane of the paper and by using projection in infinity. Plane projection becomes in this way a curve. By way of example the curve obtained for the life cycle of an isomorphic plant is shown in Fig. 1. The bisector is at the once phase boundary and also the time axis from left to right. Over it is situated the haploid domain in which the haploid stage is represented by a half wave (traced in a thin double line) symbolizing the two sexes. The diploid stage falling beneath the phase boundary is shown by the thick half wave. The descending points of intersection represent the sexual process, the rising ones the reduction. By this new method of representation every type and every peculiarity of alternation of generations (e.g. auto- and heterotrophy, symbiosis, parasitism, homo- and heterothally, mono- and dioecy, etc.) can be expressed graphically. Lack of space not permitting me to illustrate them in the present paper, I intend to show them in all detail in a later study. Here I should like to mention only that by raising or by lowering the phase boundary any type of heterotrophy can easily be represented. As the curve in question can,

* The expression "periodical ontogeny" instead of "alternations of generation" originated from Prof. Sándor Sárkány (SÁRKÁNY—SZALAI 1964, SÁRKÁNY 1969).

** This study was copied word for word from the author's original (Editorial Board).

in principle, be continued infinitely either backwards or forwards, and as all related categories developed from another (phylogeny), this new way of representation permits the evolution of ontogeny to be studied and illustrated on any phylogenetic line.

Alternation of generations must, to my mind, have evolved in connection with the aperiodic or periodic changes of the oecologic factors, it may even be regarded as the result of these changes. It is a well-known fact that in the most simple living, anuclear organisms (akaryobionta) some cells or cell-parts pass into a resting state when food gets exhausted owing to a fall in temperature or to drought, i.e. when conditions become unfavourable. Such a cell differs from the normal ones in that it is surrounded by a thick or resisting wall, its protoplasm contains less water and its life functions are reduced. Such cells are e.g. the "endospores" in bacteria or the cysts or heterocysts in the blue-green algae. These resting cells are much more resistant to deleterious heat and light effects and to drought than the rest. The simplest organisms having nuclei, the *Euglenophyceae* behave identically. If we examine the ontogeny of the simplest algae which exhibit nuclear phase change (e.g. *Chlorophyceae* s.l., incl. *Volvocales*, *Charales*) we can see that sexual processes occur in most cases when conditions become unfavourable or that at least the resting cell, the thick-walled zygote, begins to divide (by reduction!) as soon as the external factors improve. This is equally valid both for the unicellular organisms (e.g. *Chlamydomonas*) and for the multicellular organisms (e.g. *Ulothrix*, *Cedogonium*). Therefore, it is safe to surmise that nuclear phase change presupposes the coming into being of the sexual process induced by periodical changes in the ecologic factors. It is another matter that in plant cells there is a priori a similar trend. Cells are units disposing of biological (lastly chemical and physical) cohesive strength of a determined degree which in case of s.l. abundance of food are liable to breaking up (division). Unfavourable conditions transform the cohesion into adhesive affinity, the latter resulting phylogenetically in sexual differentiation. Under this aspect reduction is but a switchback, actually proved by the ontogeny of the primitive zygotic plants exhibiting nuclear phase change (see above). I cannot agree with the school of thought which emphasizes reduction division as the essence of nuclear phase change and considers the sexual process only as the equalization of reduction (e.g. ZIMMERMANN 1959, p. 54—55). In support of his theory, this author supplies genetical motives in which a certain degree of teleology is concealed. On the basis of causality we have to regard nuclear phase change as a result, and under this aspect it is the necessity of the appearance of the sexual process that will become accentuated. The facts briefly mentioned in the foregoing also speak in favour of this reasoning. Besides, the reduction theory demands a chromosome set of even numbers while in the present argumentation this postulate falls away.

The further course of the phylogeny of alternation of generations will not be discussed in detail here as it is a widely known and accepted view that the diplont types are the progressive ones. I wish, however, to stress that in the course of evolutionary progression the haploid phase is gradually suppressed by the diploid one, a phenomenon in which I perceive the phylogenetic predominance of the tendency to polyploidization within ontogeny. The different types of body structures provide different conditions and possibilities for this trend to assert itself. In unicellular organisms the progression resulted in gametic (iso- and oogamic) nuclear phase change (*Bacillariophyceae;* their cell structure is also highly differentiated). In coenoblastic organisms intermediate and gametic stages can be established (*Syphonales*, with very few species). In the *Thallophyta* there are well-known sequences culminating in the *Fucus* and *Sargassum* types (the gametophyte of *Fucus* consists of a few cells regarded by many as gametes). The highest peak of this development is, no doubt, the triple alternation of generations in the *Rodokhyceae*. However, one should not disregard the fact that between the karposporophyte and the auxiliary cells plasmogamy takes place with karyogamy falling out. I regard this process as a tendency towards triploidy and as a third sex.

The *Cormophytes* being mainly land plants with organs and tissues, offer much more differentiated possibilities for the evolution of ontogeny. In lieu of enumerating known facts I shall only mention that at the beginning the diploid stage is less well-developed and lives on the expense of the autotrophic haploid stage from which it originated (e.g. *Hepaticae*, *Sphagnales*), then by and by, it becomes autotrophic itself (e.g. *Musci frondosi*), eventually suppressing the haploid stage which becomes heterotrophic and parasitic (e.g. *Gymnospermae*). With the diplont getting the upper hand the function of the resting cell gets shifted to the spore, and in seed plants to the multicellular seed.

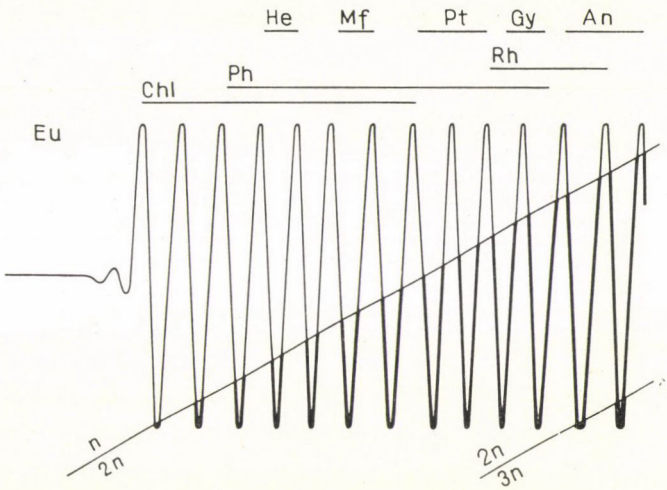

Fig. 2. General pattern of the evolution of ontogeny in a simplified form of representation n: haploid, 2n: diploid; 3n: triploid domain. Eu: *Euglenophyceae*, Rh: *Rhodophyceae*, He: *Hepaticae*, Sphagnum, Mf: *Musci frondosi*, Pt: *Pteridophyceae*, Gy: *Gymnospermae*, An: *Angiospermae*, Chl: *Chlorophyceae* s.l., Ph: *Phaeophyceae*

Double fertilization and secondary endosperm in the *Angiospermae* can be interpreted in the knowledge of the evolution of ontogeny and the general trend it reveals.

Technical literature regards the secondary endosperm as a nutritive tissue and its presence in the seed as a primitive, its absence as a progressive feature (e.g. NETOLITZKY 1926, ZIMMERMANN 1959, Soó 1963, MELCHIOR 1964, FIRBAS 1967). Concerning double fertilization, however, only teleological explanations (e.g. ZIMMERMANN 1959) are given. (The same holds for the interpretation of the endosperm.) I am of opinion that in double fertilization three sexual processes are involved and not two. The first one is the complete karyogamy of the two haploid (polar) cells resulting in the formation of the central cell of the embryo sac. It is only after the completion of this process that the so-called double fertilization can take place. This consists of the gamy of the ovule on the one hand and of that of the diploid central cell, on the other, the latter resulting in the formation of a triploid zygote. In this respect the *Angiospermae* are thus one step further than the *Rhodophyceae*.

The secondary endosperm corresponds both evolutionally and phylogenetically to a third ontogenic phase ("generation"), even if the diploid embryo formed synchronously should destroy it during seed-development (this is, phylogenetically the more primitive stage), or during seed germination (i.e. in the progressive stage). It must be taken into consideration that the endosperm of the *Angiospermae* is a relatively new, recent phenomenon in phylogeny, suppressed as yet by the stages of the less recent, conservative two-phased development.

"Reduction", therefore, takes place at present along with the deterioration of the triploid stage during which the nutrients of the latter migrate into the synchronous diploid embryo. In this interpretation, in the *Angiospermae* those are the more progressive stages in which the ripe seed exhibits a well-developed endosperm. This statement is substantiated by most of the modern plant classifications (e.g. SKOTTSBERG, PULLE, NOVÁK, KIMURA, HUTCHINSON, TAKHTAJAN in: MELCHIOR 1964; Soó 1961). I want to refer, in general, to the difference between *Dicotyledons* and *Monocotyledons* and to the characteristics of *Ranales* and *Helobiae*.

The general trend in the evolution of alternation of generations is illustrated by means of the diagrammatic representation outlined in the introductory part of the present paper (Fig. 2). The wave periods to be seen in the figure are, of course, only symbolic because in reality many thousand millions of waves ought to be traced. Furthermore, the wave periods do not (and are not intended to) show the countless ramifications which occurred in the course of evolution but are meant barely to illustrate the general trend.

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*

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REFERENCES

FIRBAS, F. (1967): Spermatophyta, in: Strasburger's Lehrbuch der Botanik. 29. Aufl. Stuttgart.

MELCHIOR, H. (1964): Engler's Syllabus der Pflanzenfamilien. 12. Aufl. II. Band. Berlin.

NETOLITZKY, F. (1926): Anatomie der Angiospermen-Samen. In: Linsbauer's Handbuch der Pflanzenanatomie 10. Berlin.

SÁRKÁNY, S. (1969): A szakaszos egyedfejlődés alapvető vonásai (The basis of alteration of generation). In: A növények világa I. (Plant World). Gondolat, Budapest,

SÁRKÁNY, S.—SZALAI, I. (1964): Növényszervezettani praktikum (The practical histomorphology). Tankönyvkiadó, Budapest, 71.

Soó, R. (1961): The present aspect of the evolutionary history of Telomophyta. Ann. Univ. Sci. Budapest, Biol., 4, 167—178.

Soó, R. (1963): Fejlődéstörténeti növényrendszertan (Phylogenetical Taxonomy). Tankönyvkiadó, Budapest.

ZIMMERMANN, W. (1959): Die Phylogenie der Pflanzen. Stuttgart.

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LECTIONES

THE BREEDING OF DWARF AND SEMI-DWARF WINTER WHEAT CULTIVARS*

According to demographers of the United Nations Organization, the population of the Earth will get doubled by 2006. Therefore, developing the most important cereal: the wheat is really a task of great prominence. In solving this task the sciences of breeding and genetics have an important role. In recent years the attention of the breeders all over the world has been called, more and more, to the short-culm wheats, to the so-called dwarf and semi-dwarf wheat cultivars the production of which is considered an effective developmental method of the potential productivity in wheat. The notion of producing dwarf wheat cultivars has come into existence relatively not very long ago. However, the tendency of breeding short-culm cultivars is of older date. It has been brought about mainly under the effect of modern tillage, intensive growing and large-scale fertilization.

The short-calm cultivars resist lodging and respond to high-dosis nitrogen fertilizers to a larger extent than any other forms, — and mostly on this as well as on irrigation depends the quantity of the crop. This is the explanation of the 20th century trend from the long straw to the short one.

As an example, it seems to be adequate to refer to the 20th century history of wheat breeding in Russia and the Soviet Union, as well as to that of France. Though in these two countries, especially in the first part of the period mentioned, mutual information was scarce, — the long culm wheat cultivars were replaced by those with short ones; as a result the straw became shorter by about half a meter. The average crops were redoubled in our Kuban.

Of course, the length of the culm in itself, is not yet determinative of the cultivar's productivity. Besides it, productive ear, good-quality kernel as well as biological properties granting the adaption to the local agro-ecological conditions are also needed. By including short-culm, productive winter wheats in the cultivation, productivity considerably increased in several countries. Thus, the introduction of the short-culm and productive *Bezostaya 1* in Bulgaria, resulted in the doubling of the winter wheat yield; broadly speaking, similar results have been obtained by introducing that cultivar in Hungary and in some other countries, too.

The fact that the short-culm, lodging resistant cultivars are important means of more efficient fertilization deserves special attention and this, being the most important factor to increase productivity, gains ground more and more in agriculture.

Today there are quite a number of data available which prove that as a result of applying large doses of fertilizers, first of all, nitrogen fertilizers, the short culm wheat cultivars might produce double the quantity of the crop. Let us show some of these data (Table 1).

It can be seen that the surplus production of the short-straw cultivars was 2.5—6 times more than that of the long-straw cultivars. An American breeder of dwarf wheat appropriately remarked that the heavy fertilization of the old-type cultivars might be compared

* Delivered at the Hungarian Academy of Sciences on June 4, 1969.

Table 1

Grain yield of short- and long-culm wheat cultivars as affected by fertilization

Country	Cultivar	Type of cultivar	Grain yield q/ha fertilized	Surplus yield compared with the control not given fertilizer q/ha
USA	Vigo	short-culm	30.2	+13.7
	Gaines	long-culm	12.8	+ 2.0
India	Sharbati Sonora	short-culm	44.15	+22.2
	S 306	long-culm	31.54	+ 7.8
Soviet Union	Bezostaya 1	short-culm	54.2	+22.2
	Novoukrainka 83	long-culm	38.7	+ 9.3

with the abundant fodder given to a pony in the hope of getting the performance of a horse, though whatever fodder a pony might be given, it will always remain a pony.

In irrigated cultivation the advantages of the short-straw wheats are indisputable. The long culm wheat, when irrigated, generally lodges to a great extent, and it quite often happens that their productivity decreases compared to non irrigated wheats.

In Europe the breeding of short-culm winter wheats was initiated by the well-known Italian breeder STRAMPELLI who was the first to make crossings with the short-culm Japanese cultivar *Akagomughi*. By making use of that cultivar, he produced in 1916 one of the first short-straw Italian winter wheats, the *Ardito* which, in those days, became rather widespread.

San Pastore 14, an Italian cultivar produced later on by Professor MALIANI, is a winter wheat grown nowadays in the largest area of Italy. It is, however, to be noted that besides their high productivity, the Italian wheat cultivars are characterized by considerable negative properties, such as poor winterhardiness, the trend to tear out of the ground together with a portion of the root, poor quality indices of the kernel and so on. All these negative features pass over to the hybrids. Thus, certain breeders came to the conclusion that the short-straw property is in connection with all the negative properties of the Italian wheats which, however, cannot be said about all the short-culm wheats.

Later, in the decade from 1940 another very effective source of dwarfism was found in Japan; this is the cultivar *Norin 10* which is said to have 3 additive recessive genes of dwarfism.

By making use of this source of dwarfism, dr. N. E. BORLAUG and his co-workers carried on a wide-scale program of breeding dwarf wheats in Mexico and they succeeded in producing quite a series of short culm wheat cultivars highly resistant to rust-species. The Mexican dwarf wheats have caused a revolution in the agriculture of India, and have gained ground quickly in Pakistan, Turkey, Iran and in other countries.

An important peculiarity of the Mexican dwarf wheats is their high-grade ecological plasticity. It can be established that their adaptability is considerably wider than that of the other cultivars. They are insensitive to photoperiod which renders them suitable to be grown at divergent latitudes; they comply with various cultural conditions especially in irrigated cultures. In Israel, too, in the border-zone of wheat growing areas the high-grade resistance of the semi-dwarf wheats has been observed. Canadian professor SHEBESKI attributes great perspective to the growing of these cultivars even on drought-stricken prairies, and carries on intensive breeding by making use of them. The properties of excellent resistance,

of being short-culmed, the resistance to lodging, drought-tolerance, high-degree ecological plasticity: these are the characteristics of the Mexican wheats that induce the breeders to make use of them as quickly and broadly as possible in their breeding work especially in the breeding of spring wheat.

In the Soviet Union the priority of producing short-culm wheats is ours. Based on the intraspecific hybridization of ecologically and geographically remote forms, the work started in the middle of 1940—50. *Bezostaya 4* and *Bezostaya 1* are the first short-culm winter wheats developed in the Soviet Union. Nowadays the *Bezostaya 1* is one of the winter wheats grown on the largest area not only in our country but also in quite a number of countries abroad. In the Soviet Union this cultivar is grown on 7.5 million hectares, as for abroad, its sowing area amounts to more than 3 million hectares. *Bezostaya 1* owes its short culm to the Japanese cultivar *Aobakomuchi*, this being one of its early ancestors.

Bezostaya 1 having complex good properties is, nowadays, widely used as a crossing partner by Soviet breeders as well as by many foreign experts. Recently, by making use of this cultivar, numerous new, productive, lodging-resistant, winter wheat cultivars, have been produced in our Institute as well as in other institutes of the Soviet Union. These are in the Mironovka Wheat Breeding Institute the *Mironovka Yubileynaya 50*, in the All-Union Institute of Breeding and Genetics the cultivar *Odessa 51*, in the Ukrainian Institute of Plant Growing, Breeding and Genetics the *Kharkov 63*, in the Maize Institute the *Dnieper 521*, and so forth. By making use of *Bezostaya 1*, from crossings of ecologically and geographically remote forms, the new, prospective cultivars: *Avrora* and *Kavkaz* had been selected in our institute and released in 1967 for state performance experiments. These very productive cultivars resist lodging, and have a high and complex resistance to all three kinds of rust and to powdery mildew, their culm is not long (106—114 cm) and the flour- and baking quality of the grain is very good. This can be seen from the following experimental data gained in the technological laboratory of our Institute (Table 2).

At the state cultivar testing everywhere in the regions of North-Caucasus und Ukraine, similar to our experiments, the *Avrora* and the *Kavkaz* cultivars have surpassed the standard

Table 2

Quality parameters of the wheat cultivars Avrora, Kavkaz and Bezostaya 1

Parameters	Years	Cultivars		
		Avrora	Kavkaz	Bezostaya 1
Grain yield, q/ha	1966	54.9	55.3	50.9
	1967	66.4	66.1	54.4
	1968	72.9	74.0	68.9
	Average	64.7	65.1	58.0
1000 grain weight, g	1965—68	45	44	43
Hl-weight, kg	1965—68	79.6	77.7	79.3
Protein %	1966—67	15.62	15.87	14.52
Gluten %	1965—68	33.2	33.2	31.6
Volume of bread, cm^3	1965—68	584	585	568
Porosity	1965—68	4.7	4.8	4.7
Baking quality	1965—68	4.8	4.9	4.8

Bezostaya 1 regarding grain-yield, in some cases the surplus being 5—10 q/ha or even more, meanwhile the average yields reached or even surpassed 60—70 q/ha.

The new cultivars show good response to irrigation. At the Timoshovo experimental station the cultivar *Kavkaz* had, in irrigated culture, a yield of 87.4 q/ha grains: 17.8 q/ha more than that of *Bezostaya 1.*

The first data of international cultivar tests also prove the high productivity of *Avrora* and *Kavkaz.* Thus, in Czechoslovakia in the Chech beet-zone, at the Sedlec station the *Kavkaz* produced 85.4 q/ha grains, 16.5 q/ha more than the yield of *Bezostaya 1.* In the German Democratic Republic at Hadmersleben experimental station the grain yield of the *Kavkaz* and of the *Avrora* surpassed the standard cultivars at a grain yield level higher than 70 q/ha. In Bulgaria, too, our new cultivars yielded generally more than the *Bezostaya 1.* All these data prove the excellent productivity of the new cultivars.

It is worth mentioning that the increase in the grain yield of *Avrora* and *Kavkaz* can be attributed, as a matter of fact, to the greater productivity of the ear, i.e. to the higher number of spikelets and grains per ear, and to the higher weight of the grain. Regarding grain-weight per ear, the *Avrora* and the *Kavkaz* surpass the *Bezostaya 1* by 20—28 per cent. Both the cultivars are relatively short-stemmed; however, the length of the culm is somewhat (3—10 cm) longer than that of *Bezostaya 1,* at the same time the share of the grain yield in all the overground portions roughly agrees with the corresponding parameters of *Bezostaya 1.* This shows that by breeding new cultivars, the productivity might be considerably enhanced without decreasing the culm-length. However, by no means should we draw the conclusion that we need not try to produce cultivars with shorter stem. It is a well-known fact that if the stem is shorter and stronger and the productivity of the ear is greater, then the share of all the overground parts will increase, and consequently the average yield per hectare will show an increase.

Therefore, one can hardly agree with the opinion of those scientists according to whom the "critical" level of the culm-length has already been reached in winter wheat breeding, and to aim at a shorter stem would not be advisable since a further decrease of the stem-length would be at the expense of productivity. In order to prevent this, it is, evidently, necessary that the short-culm wheats should possess productive ear, high-grade photosynthetic activity, the good capacity for tillering and other advantageous properties, i.e. it is necessary to produce such productive forms which are not only of short stem and whose ratio in the grain/straw yield is favourable but whose organic matter (biomass) production is also conspicuous.

In the course of breeding short-culm winter wheats, the most important property is the grain yield per ear. Only by thoroughly changing this property, i.e. by increasing the value of grain/ear, a considerable increase in the productivity of the new cultivar can be obtained. This is well demonstrated by the high-yielding cultivars like *Bezostaya 1, Avrora, Kavkaz* and others (Table 3).

Table 3

Weight of grain/ear and the grain yield of winter wheat cultivars

Cultivar	Grain yield 1966—68		Weight of grain/ear	
	q/ha	%	g	%
Novoukrainka 83	44.7	100	1.0	100
Bezostaya 1	58.0	128	1.32	132
Avrora	64.7	145	1.65	165
Kavkaz	65.1	145	1.65	165

From the table it can be seen that the grain yield of the cultivars changed and increased, in parallel with the grain weight/ear parameter. Therefore, in the course of breeding short-culm wheats, the main attention is to be concentrated on the possible development of ear-productivity. Neither our investigations nor those of other scientists prove the negative correlation between the length of the stem and the grain weight/ear value. Consequently, it is possible to produce such short-culm, long-ear wheat forms whose grain yield per ear is high. In order to increase the potential productivity of the ear, besides the variation within the species of common wheat, it is supposed that the use of remote, intergeneric hybrids might also be effective. In this respect the *Triticum* × *Elymus* hybrids, the constant large-ear forms of which have been produced by academician CICIN, as well as other hybrids can be considered interesting.

In the course of breeding short-stem winter wheats, we are of the opinion that, besides using Japanese cultivars and their offsprings as well as the Mexican and Indian spring dwarf wheats, it is very important to look for and to produce new sources of dwarfism having winter genotype and higher winterhardiness, and with the characteristic ear production of the latest European intensive winter wheat cultivars. Furthermore, dwarf forms having excellent baking quality would be needed as, for instance, in India no breeding work is going on aiming at the development of this quality since generally bread produced without fermentation is consumed there. The experience of our Institute is that the induced mutation can be made use of for producing new dwarf winter wheats. Recently, dwarf mutants have been produced in the standard winter wheat cultivars (*Bezostaya 1*, *Rannaya 12* and others) by applying chemical mutagenes (especially nitroso-methyl-uretane). One mutant of *Bezostaya 1* is now being studied in performance trials and is used in crossings. This, the *Bezostaya 1* dwarf M-1 is of a stem-length of 50—60 cm, its ear is normal, the quality is excellent, the kernels are big, and it differs advantageously from the other dwarfs regarding its conspicuous winter-hardiness which can be established also from Table 4.

Table 4

Overwintering of winter wheat cultivars

Cultivar	Percentage of the plants overwintered in 1968
Bezostaya 1	98
Bezostaya 1 dwarf M—1	100
Accia	15
Norin 2	0
Produttore	5
Norin 10	0

For the time being quite a series of new winter wheat dwarf mutants have been produced. I should like to mention that research worker ZSHOGIN has produced a *Bezostaya 1* dwarf mutant in which the share of the kernel is 85 per cent of the whole above ground parts while with the majority of similar forms this parameter agrees with the starting form (40—50 per cent). In the same cultivar short-culm, compactoid mutants with outstanding protein content (18—22 per cent) have been produced. Presumably, all these dwarf-forms are interesting as partners in crossings with common forms. Dwarf mutants are now brought about in the new productive forms, in the *Avrora*, *Kavkaz* and others.

In possession of the new starting material, it is assumed that the breeding of new lodging-resistant, low-stemmed winter wheats can be more effective; of cultivars having complex disease resistance, excellent quality, which, making the most economical use of water and nutrient, are able to have high and steady grain-yield.

It is to be mentioned that short-stem wheats are necessary also for producing hybrid wheats on sterile basis. Hybrid wheats should be, by all means, of intensive type though it is a well-known fact that in F_1 transgression of the plant-height can be observed. In the majority of our F_1 hybrids the stem is longer than that of the parents, and with the others, almost without exception, it is intermediate; there was not a single case where the stem of the F_1 hybrid was equally long or shorter than that of the short-culm parent. Therefore, when choosing partners for hybrid wheat, the shorter wheat-forms should be given preference.

Finally, we want to submit the first data of testing two semi-dwarf winter wheat lines. These lines had been selected from crossings of Italian, short-culm varieties with our own cultivars. These data show persuasively that it is purposeful to go on with the shortening of the stem of the winter wheat. In June 1968 when there were stormy showers causing heavy lodging, these semi-dwarf lines showed the highest lodging resistance and their grain yield considerably surpassed that of the standard *Bezostaya 1* as can be seen from Table 5.

Table 5

Grain yield and lodging resistance of winter wheat cultivars

Cultivar	Grain yield q/ha	Deviation from the yield of the standard		Lodging resistance	Plant-height cm
		q/ha	%		
Lutescens 820 h 745	82.0	+12.2	+18	4.8	85
Erythrospermum 811 h 1262	79.2	+9.4	+13	4.9	85
Bezostaya 1	69.8	st.	st.	3.8	107
Produttore	61.2	−8.6	−13	4.7	90

From these data it can be seen that the culm-length of the semi-dwarf lines is, by 22 cm, shorter than that of *Bezostaya 1*, and their lodging-resistance, by about one point, better than that of the standard. Otherwise, it is well known that even non-considerable lodging might result in a decrease of production that can be explained by the decreased activity of photosynthesis. In our experiment the culm of the *Bezostaya 1* plants got lodged thus giving, evidently, less production than the semi-dwarf lines which remained almost standing.

In our opinion these data show that the works aiming at producing sturdy semi-dwarf wheats with still shorter stems than the present ones, have wide possibilities.

An Indian author said — and nowadays the whole wheat breeding tends to produce dwarf cultivars all over India — that: "if the accumulation of the genes of dwarfism is continued in new wheat forms, similar to the ostrich, it would put its head into the earth in which case wheat harvesting would become similar to the gathering of the potato". Of course, wheat will not turn into a tuber crop in spite of the fact that there already exist mutants the ear of which breaks forth from the earth. However, these will hardly be of any practical importance. For us, of course, it is evident that the culm of the wheat should be short, not longer than 50—60 cm of which one-fourth or maybe one-third should fall to the ear.

Such wheats make possible not only a considerable increase of the grain yields, — with high doses of nitrogen fertilizer, the yields will reach 100 q/ha or even higher, — but will en-

hance, at least will double, the achievement of the harvesting machines. The expenses of gathering straw will be decreased to the minimum; for the time being these expenses amount, at least, to the half of the total costs in the gathering of corn. It might be that the straw of the dwarf wheats will be simply ploughed in the soil.

There is no doubt that changing, as discussed above, the morphological and biological properties of wheat might and will result in its further potential productivity.

The new wheat cultivars of high productivity produced in this way, will possibly meet, more efficiently, the more and more increasing food demand of humanity.

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RESEARCH ON HYBRID WHEAT AT MARTONVÁSÁR, IV*

In addition to their previous publications, the authors report on some recent results obtained in their investigations on the following topics: 1. Restorer fertility rate as affected by the number of backcrosses and selfings. 2. Fertility restoration as affected by male sterility sources and restorers. 3. Male sterile wheat $\times$ rye crosses.

1. Restorer fertility rate as affected by the number of backcrosses and selfings

Data presented in Table 1 support our statement published earlier (RAJKI, E.—RAJKI, S. 1968) according to which "only a repeated selfing succeeding the backcross cycle and combined with fertile selections will lead to the isolation of stable, homozygous restorer lines".

Table 1

Restorer fertility rate as affected by the number of backcrosses and selfings
Martonvásár, 1968

Restorer	Number of isolated plants	Number of kernels / isolated spike $\bar{x}$	Per cent of sterile plants
Rf Mir^7	13	7.5	69.5
Rf Mir^6 S_1	20	19.2	25.0
Rf Mir^5 S_2	45	29.4	8.9
Rf Mir^6	120	16.7	31.7
Rf Mir^5 S_1	267	26.0	8.2
Rf Mir^4 S_3	47	39.0	2.3
(Rf Mir^4 S_2) Mir	86	27.1	6.4

2. Fertility restoration as affected by male sterility sources and restorers

Of the male sterile lines (Table 2) in A_1 *Ae. caudata* was the donor; in the others *T. timopheevi* was the donor and different *aestivum* varieties served as recurrent parents (RAJKI, E.—RAJKI, S. 1966).

* Paper presented on July 15, 1969 at the International Hybrid Wheat Conference in Hadmersleben.

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Table 2

Fertility restoration as affected by male sterility sources and restorers
Martonvásár, 1968/69

♀	Conditions	♂						
		Rf Mir^3	Rf Mir^{2}S$_1$	Rf Bez^4	Rf Skoro^{2}S$_1$	R 35	Primepi	Marchal
A_1	Greenhouse		○	○○	×××	×○○	×○○○	○○
	Field				□×	□×○	□××○	
A_2	Greenhouse	××××○	×	×○○○		□□×○	○○○○	○○○
	Field		×	□□□		□ ×	□□□××	
A_3	Greenhouse	×××	○	×○○	○○	×○	○○○	×
	Field		×	□×	□□	□	□	□
A_4	Greenhouse	×	×	×○	×××	□××	×○○	
	Field		□	□	□□×	□×	□□	
A_5	Greenhouse	××	□	×○○		□□×	×○○	×
	Field		□	□		□ □	□	□
A_7	Greenhouse	××○	×	○○○		○○○	×	×○
	Field			××○		○○	○	
Ms selected from R_w	Greenhouse		×	××○		□□	××	×○
	Field			□		□□	□	□
♂	Greenhouse	×				□□□××	×××××	□□□□□
	Field	□□□××	□□□×	□□□××	□□□×	□□□	□□□	□□□

□ = entirely fertile lines × = partly fertile lines ○ = sterile lines

Table 3

Male sterile wheat × rye crosses
Martonvásár

1965/66	1966/67	1967/68	1968/69
1. Ms Skoro^3 × Rye → F_1	× Rye ∅		
	× Skoro → BC_1 ∅		
2. Ms Skoro^5 × Rye → F_1	× Rye ∅		
	× Skoro ∅		
3. Ms Skoro^5 × Rye → F_1 —	× Rye → BC_1 ∅		
4. Ms Skoro^5 × Rye → F_1	× Rye ∅		
	× Skoro → BC_1	× Rye ∅	
		× Skoro ∅	
5. Ms Skoro^5 × Rye → F_1	× Rye ∅		
	× Bez → BC_1	× Rye →	
		× Skoro →	

Of the restorers designated Rf or, respectively, R *T. timopheevi* was the donor. *Primepi* and *Marchal* are restorer lines isolated from the same winter wheat varieties. Data relate to male sterile × restorer F_1 lines. Some F_1 lines were studied under greenhouse and field conditions collaterally.

The presented data prove that the fertility of different male steriles was restored by different restorers to different degree.

3. Male sterile wheat × rye crosses

In Table 3 the schemes of male sterile wheat × rye crosses referred to earlier (RAJKI, E.—RAJKI, S. 1967), are presented. These crosses aim at obtaining a) open flowering wheat, and, b) male sterile rye. It is remarkable that BC_2 was reached by the hybrid population only in which the first "back-cross" was made by Bezostaya wheat instead of Skorospelka one.

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REFERENCES

RAJKI, E.—RAJKI, S. (1966): Research on hybrid wheat at Martonvásár. Acta Agr. Acad. Sci. Hung., **15**, 199—214.
RAJKI, E.—RAJKI, S. (1967): Research on hybrid wheat at Martonvásár, II. Acta Agr. Acad. Sci. Hung., **16**, 240—246.
RAJKI, E.—RAJKI, S. (1968): Research on hybrid wheat at Martonvásár, III. Euphytica, Suppl. **1**, 43—48.

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CHRONICA

ÁRPÁD DEGEN
1866—1934

Á. Degen was one of the greatest and most important personalities of Hungarian botany as well as of agricultural science.

He was born in Pozsony (Now: Bratislava, Czechoslovakia) on the 31st March 1866.

That town used to have a leading position in every field of cultural life, there has always existed a vivid scientific and intellectual life there. Botany, too, had old traditions at that time which is proved also by the two local books on flora, those of Lumnitzer appearing in 1791 and of Endlicher published in 1830.

At the time when Á. Degen made his grammar-school studies in his native town, a small, however, very active group was dealing with botany and producing many a scientific result. Young Degen soon found the way to join them and thus, as early as at the age of 17, he had three publications appeared on the flora of Pozsony.

After the final examination he enters the medical faculty of the Budapest University. Taking into consideration the situation of botany prevailing in this country at that time, it will be understood that he would have had hardly any other choice. It was just the year of Degen's being born when, after a series of great predecessors dealing with flora-research work and taxonomy, Lajos Jurányi, being engaged in cytology and the physiology of cell, was appointed to the Botany Department of the University. Consequently, the taxonomic and phytogeographic research work having been in the focus of interest so far, was entirely

ousted from the university. Thus, Degen could not have got from botany what he needed and this was why he asked to be admitted to the Medical Faculty. However, besides his university studies, he remained faithful to botany. In the years 1883—1884 he went to the High-Tatra where he made the acquaintance of Hugo Lojka together with whom he travelled about in Bosnia and Herzegovina in the year 1886. He then went to the Lower Reaches of the Danube and to Spa Herkulesfürdő while later, he was wandering all over the Retyezát — again in the company of Lojka. That year was of decisive importance in Degen's life because when travelling on the Illyrian territory, the Lower Reaches of the Danube, visiting the Gate of the Balkans and the Southern Carpathian Mountains, — he made his decision that following Hungarian traditions and the examples of Imre Frivaldszky, Victor Janka, and József Pantocsek he would spend his energy on exploring the flora of the Balkan. As a result of these wanderings his work discussing the flora of Herkulesfürdő, was published in 1907.

Meanwhile, he had got his medical degree working first at the Surgical Clinic and later having his private medical practice, but he did not give up being interested in botany.

In 1890 he travelled in Turkey and collected material at the Bosporus and on both shores of the Sea of Marmora; he then visited, on a sailing boat, the Asia shores of the Black Sea and finally went — as the first botanist ever been here — to the island Samothrake in the north part of the Aegean Sea. The results were published in 1891.

Being a wealthy and financially independent man, he has always generously supported collectors. Thus it was with his aid that János Wagner was able to go to Bulgaria and gather plenty of material in the years 1892—1893. In order to have it worked up in a material collected mainly in Albania and Montenegro was also handed over to Degen by prof. Antonio Baldacci from Bologna. When by the elaboration of these collections the first results were published together with his own results, soon the attention of the scientific world was turned to them especially when he started to publish his taxonomic observations from the year 1891 on in the series under the title "Comments on Some Plant Species in the East." No sooner than this, the explorers of the Balcan and the Near East began, one after the other, to submit him their material for determination or for his critical reviewing; this, of course, brought about the quick increase in Degen's international reputation.

Due to these activities, Degen necessarily needed vast comparative herbarium-material and also a suitable comprehensive library. Since his economic situation made it easy for him, he could afford to realize both requirements. He had started to build out his extensive barter-possibilities in the frame of which he supplied collections in foreign countries with mainly domestic plants getting in exchange plenty of very valuable foreign materials. He rendered it possible for many an explorer to travel in order to collect material but of course, considerable part of the collected material became his property. Due to his favourable financial situation, he could afford the procuring of any collection and exsiccata-material. It was in this way that at the time of his death he owned the largest and richest private herbarium in Europe unrivalled in its value, containing 300 000 sheets.

Similarly had he developed and brought to perfection his library which the almost entire literature referring to the Balcan and to the Near-East was composed of; but he also procured most of the books referring to other parts of Europe, among them very valuable curiosities. As we can see he was in the position to achieve alone what generally can be achieved by a scientific institute only.

In the columns of the Österreichische Botanische Zeitschrift altogether 40 critical taxonomic comments are published on plant species of the East among which the description of several new species are also to be found.

Realizing that a botanic paper would be needed at home, too, he launched a Hungarian periodical under the title "Magyar Botanikai Lapok" (Hungarian Botanical Review) in 1902 sponsored and published all by himself. By doing so, all problems of publication were solved.

It is typical for Degen's high intellectual level that the periodical appeared, besides in Hungarian, also in another European language — first in German — and thus the published results were easily accessible for foreign people, too. As it might be seen, the principle generally adopted today, according to which results that might meet with interest abroad, too, should be published in foreign languages — had been realized as early as that time. The periodical ran into its 33rd volume, the last of which appeared in 1934 in the year when he died. It could appear thanks to the generosity of his widow.

Among Á. Degen's critical taxonomic works the greatest one was the monographic working up of indigenous roses for the "Hungarian flora" (published in 1925) by Sándor Jávorka.

The grandest achievement of his flora-research work was the exploration of the Velebit mountain which he started in 1905. The vast work consisting of 3 volumes with a very wide scope, had been ready on the whole, however, Degen was not to live to see its being published. It was only after his death that it could appear in 1936—38 in German language published by the Hungarian Academy of Sciences. The important task of preparing for the press as well as the writing of Vol. IV being a Hungarian summary, was made by his co-worker Géza Lengyel who used to accompany him to most of his exploring journeys. The full extent of the 4 volumes is 2116 pages.

It has to be mentioned that he was very busy in the floristical exploration of the Sárhegy ("Mud Hill") near Gyöngyös: that work, however, remained in the form of manuscript only.

Since the taxonomy and plant-geography trends had been entirely ousted from the Budapest University, Á. Degen became — besides the Botanical Collection — the centre of these trends in this country. He was always ready to give free run of his herbarium and his library to those approaching him, and was always willing to help anyone by his vast knowledge and appropriate advice. Thus it seems not to be surprising that it was him that Ignác Darányi the Minister of Agriculture of that time, entrusted with the leadership of the Institute for Seed Examination in 1896. Darányi was aware of the fact that for leading and developing a modern and high-level institute only a man with a broad knowledge of plants and plant-geography would be suitable, one who is at the same time highly educated and speaking several languages as well. By that time more than 40 botanical works of Degen had appeared and though his original profession was that of a physician, no botanist existed in those days who would have been qualified in this manner and to such a degree.

Degen knew very well what his task was. The special problems arising from the mass-work of seed-sample examination could be solved only with the assistance of highly educated people, excellent equipment and a rich library. To this effect he started to equip and develop his institute and launched the 2 exsiccata publications, the collection of Hungarian Gramineae and of Hungarian Cyperaceae. Thus became the Institute for Seed Examination a high-level scientific centre of agricultural botany having also very good international reputation; as to himself, he became to be considered an authority on that special subject, too. He was capable to solve the most difficult problems and hold the first place in Hungarian seed examination throughout 38 years.

All the time he made every effort to raise the position of Hungarian seeds to international level. He has worked out the official seed-examination rules, the rule of state metal-locking; Degen took also active part in the international organization brought about for standardizing the methods of examination and in the elaboration of the international rules coming into force in 1921.

He had studied the whole problem of dodder (*Cuscuta*) very thoroughly and as a result he was elected president of the international Committee. He was also deeply concerned with the problem of beet seed and also with the appearance of quite a series of noxious weeds and the possibilities of their control.

His death has caused deep regret and general emotion not only in this country but also abroad, since not only Hungary was bereft of a great man, — his passing away meant great loss in far countries, too.

The deep regret can be well understood if we consider the fact that Science has lost an expert being highly esteemed both in the field of botany and in that of seed examination. The man who passed away had been the author of 1039 publications and had spent all his life in continuous work offering his vast fortune almost entirely for scientific purposes.

A considerable part of his collection has perished in consequence of the events of war, the library became brought up and lost, however, all the great things Degen's mind had created and had put down: his publications the number of which is more than thousand, among them the "Magyar Botanikai Lapok" (Hungarian Botanical Review), the Flora velebitica; the collection of local grasses and sedges and some others have survived, — being a credit to Hungarian botany and a benefit of all mankind.

Z. E. KÁRPÁTI

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RECENSIONES

Z. KIRÁLY: *A növényi betegségellenállóság élettana* (The Physiology of Disease Resistance in Plants). Pages 1—138. Akadémiai Kiadó, Budapest, 1968 (in Hungarian).

Although several books appeared recently on the physiology and biochemistry of resistance to plant diseases, the present book should be regarded as a valuable addition to the literature in this field because the topic is dealt with in a quite different way. In discussing the subject, the Author does not follow the traditional way of discussing the material according to the major metabolic functions of the plant in health and disease, pointing out the differences, and trying to draw conclusions as to the role of various physiological processes in pathogenesis and/or resistance. In the present book the material is rather arranged according to phytopathological concepts which constitute the framework of presentation.

Two main sources of "resistance" are distinguished, (a) axenia and (b) defence reactions. Factors involved in axenia are divided into two groups: (1) chemical and (2) morphological. The emphasis is laid, however, not on axenia but on the active "immune" (defence) reactions including (1) induced and (2) spontaneous defence mechanisms. Under these two headings the following phenomena are dealt with: immunity proper, premunity, normosensitive spontaneous defence reactions (reactions against weak pathogens, detoxification, histological demarcation) and hypersensitive defence reactions (histological aspects, the oxidation-reduction hypothesis, phenol metabolism, nitrogen metabolism).

The main distinguishing feature of the text, as compared to other works in the same field, is the description of own experiments pertaining to the subject. The very rich experimental material of the author is interwoven into the text in a way that the unity of the whole is not lost. This is ensured by the well designed structure of the book based mainly on Gäumann's ideas and terminology.

Fungal, bacterial, and viral diseases are equally dealt with, perhaps the greatest emphasis being given to the hypersensitive reaction induced by fungi and viruses.

The style of the book is very good. Part of the experimental material is presented in 53 tables and 45 figures and in some photos the quality of which is acceptable. The literature reviewed is selective with apparent concentration on the important papers. About 350 articles are referred to.

The book is greatly recommended to plant pathologists and to plant physiologists interested in pathological aspects of plant metabolism.

G. L. FARKAS

G. UBRIZSY, J. VÖRÖS: *Mezőgazdasági mykológia* (Agricultural Mycology). 576 pages, 247 figures and 193 tables. Akadémiai Kiadó, Budapest, 1968 (in Hungarian).

Monographs on macroscopic fungi and some minor groups of microscopic ones have already been published in Hungary. This stop-gap, long expected work is, however, the first detailed treatise on phytopathogen fungi, that group of the mycoflora which is richest in species. This work may be regarded as a taxonomic book completed with thorough

general introduction, methodological guide, glossary and indexes. As to the agricultural practice (etiology, control) the book refers to senior author's Phytopathology (Ubrizsy G.: Növénykórtan) published in two volumes of which it is an indispensable supplement concerning the identification of fungi; while as a summary in the aspect of pure science it is a full, independent work.

The book is divided into five main parts:

I. General part. Includes a general characterization of fungi (in relation with morphological features the micromorphological features too). Authors give also a brief biological summary which deals with the chemical composition and nutrition of fungi, the biology of parazitism and the problems of control. The chapter on the taxonomy of fungi excels: authors make a survey of the former taxonomic attempts and present a system of their own which seems the most suitable at least on a contemporary level. Another remarkable chapter of the general part is an ample summary (40 pages) on damages made to forest trees and wood, illustrated with excellent photos. Particulars about mycorrhiza are also included in this chapter.

Authors' concise biological knowledge, manifest in every page, makes the whole general part an attractive reading without causing the terse data to weaken.

II. Methodological part. Discusses methods frequently used in identifying fungi (cultural techniques, culture-medium formulae, microscopic examinations, artificial infection).

III. Specific part (Taxonomy). Authors give first a general key up to the level of families. This is followed by a characterization of orders and families in the succession of authors' system. They represent the evolution of major types by well arranged sketches. In the families they give an identification key up to genuses and in the major genuses up to species. The great number of good original micro- and macro-photos are worth mentioning.

Not only fungi causing economic losses but also the majority of plant parasites of the Hungarian flora are included. In addition, many so called mould fungi are mentioned too, which regularly appear in laboratory tests as infections, therefore it is important to know them, in order to be able to separate them for certain from the pathogen fungi.

Authors compiled an enormous material on the 311 pages of the special part: the number of genuses included is 650, that of the species 3000. It may occur that a reader of the book would sometimes like to have more detailed descriptions and more pictures. However, with the help of the book the majority of microscopic fungi found on plant materials can be identified all the same and, if somebody wishes to go into details, the references of the book will give him all facilities.

IV. Glossary. In mycology, where the number of terms used is so high that even a specialist can easily become puzzled, works are usually completed with glossaries. Authors' glossary is rich (they employ 500 key-words), the terminology is precisely explained in a well understandable way.

V. Appendix. Consists of a literary list referring to 500 works, and of two indexes, 38 and 12 pages each, on the names of fungi and host plants respectively. The indexes make the book much easier to use.

In all consideration this is a work that will be an everyday help to all dealing with phytopathogen fungi in this country. And the same part it will take all over central Europe when language barriers of accessibility fall.

J. Zsolt

Á. Boros: *Bryogeographie und Bryoflora Ungarns.* Akadémiai Kiadó, Budapest, 1968.

The author — a honorary member of the British Bryological Society — described bryogeography of Hungary as a result of his 40 year — research activity. The book with its 450 pages and 85 pictures — mostly original photos — occupies a particular place in world literature, as far as its structure and exhaustiveness is concerned, because it characterizes all regions of Hungary, i.e.

mountains, rolling lands and the Great Plain alike, as natural and plant geographical areas each — on the basis of the author's own research and record. It deals with the ecological and phytocenological conditions of Hungarian bryums, with the general rules and features of their geographical distribution; then, following a bryogeographical characterization of the individual regions the author compiles in detail the varieties occurring in Hungary, giving their distribution, ecological data and their character as flora element. Relying on the literature the chromosome number and the diploid or polyploid character of the species, the phytocenological units in which they occur in Hungary are included as well as the domestic literature concerning the individual genuses and species. Then the flora element groups (e.g. circumpolar, boreal), their percentage distribution and even the fossile data which support the phylogenetic research on the bryoflora evolution are presented in tables. The book is completed by detailed references and a full index. In this latter the major geographical names, geobotanically significant mountains, valleys, moors and other geographical units are found that can be well applied not only by bryogeographic but plant geographic experts and in particular by foreign researchers. A foreigner who hardly knows Hungary will learn from the index where to look up the geographical sites like e.g. Bátorliget, Baláta-tó, Rámszakadék, Miklóspál-hegy, Nagypéterménkő, Kemencepatak-völgy, Rigóc-patak, Tátika, Kisszénás-hegy, etc. which are difficult to find in geographic books and maps.

Author endeavoured to study every location where bryums grow. Thus, the book deals with bryum associations growing in dug wells, caves, sandhills, roofs, thermal springs, in the lake Balaton, in the river Danube, on the most divergent rocks, moors, aluminous sites, etc. He deals in detail with the relationship between rocks and bryoflora.

The plant geographic map of the book which, besides the plant geographical arrangement, shows also the regional units, is of particularly great value; it represents the distribution of beech and Scotch fir, which provides the plant geographic map with a climatic background. This map was completed by considering — over and above the frontiers of bryogeography — the whole vegetation.

The monograph consists of the following main parts:

I. History of bryum research
II. Ecological conditions of Hungarian bryums
III. Cenological conditions of Hungarian bryums
IV. Characterization of bryum horizons in the plant associations of Hungary
V. Bryogeographical characterization of the Hungarian plant geographical areas.
   1. Flora regions of the Hungarian Medium Height Mountains (Matricum)
   2. Flora regions of the Trans-Danubian Area (Praenoricum or Transdanubicum)
   3. Flora regions of the Great Plain (Eupannonicum)
VI. Bryoflora of Hungary
   I. class: *Anthoceratopsida*
   II. class: *Hepaticae (Hepaticopsida)*
   III. class: *Musci (Bryopsida)*
      1. subclass: *Sphagnidae*
      2. subclass: *Andreaeidae*
      3. subclass: *Bryidae*
      4. subclass: *Buxbaumiidae*
      5. subclass: *Polytrichidae*
VII. References, index, coloured plant geographical map of Hungary.

Investigations of the bryum distribution largely contribute to an even fuller knowledge of the climate, soil conditions and vegetation of Hungarian regions.

L. SZABÓ

E. W. CRAMPTON, L. E. HARRIS: *Applied Animal Nutrition*. W. H. Freeman and Company. San Francisco. 2nd edition 1969. 753. 41 Figures within text, 143 Tables within text and 1000 Tables of more important feedstuff compositions in the appendices.

The first edition of the book was published in the year 1956, the author was *E. W. Crampton* himself. The aim of this book was to contribute to practical utilization of the theoretical knowledge of animal nutrition. *L. E. Harris*, one of the first ranking professors of USA joined in the 2nd edition as co-author to the excellent Canadian expert of animal nutrition. Both participated in the responsible committee of the American Academy of Sciences, where they carry out the modernization of the nutrient requirement standards for farm animals. This standards are known in the whole world as NRC standards (National Research Council). They collected the data of approximately 7500 feedstuff-compositions and their various names, which are being fed throughout the world. All kinds of feedstuff were determined after the method of *L. E. Harris* and were supplied with a code-number. Thus, till now, about 5700 feedstuff has got official names. All names were arranged after their initial letters. Under the official names they reported the data on feed compositions and code-numbers, and by other denominations they referred only to code-numbers.

One can see, as stated above, in what close connection the authors are with the theoretical and practical problems of the nutrition of farm animals.

The book is divided into 22 chapters and appendix. The related chapters are grouped, thus the book is divided into 5 parts. At the end of each section there is a summary.

Chapter one introduces the basic principles of the names of the feedstuffs and their classification, taking into consideration the so-called NRC nomenclature of the feedstuffs. In our opinion it has a great advantage that the collected data were converted into metric-system, which relieve us of much tiresome conversions. Where more data were available, the variation-coefficients were published too. 80 kinds of feedstuff components were taken into consideration. Of course, all data are not available for all feedstuffs.

Chapter two deals with the Weende analysis and gives its critical evaluation.

Chapter three shows, in detail, the expression of energy content of feeds and the energy turnover, as in USA since 1958 the nutrient values of feeds and the nutrient requirements of farm animals are expressed in calories in addition to TDN. The terminology that plays a role in the energy turnover and the shortened forms are described in detail. Later on in this book only these abbreviations are used. At the end of the book we can find an assortment of the used abbreviations, but unfortunately these are not included there. Looking for abbreviations in several places, makes reading difficult especially for foreigners.

Chapter four gives a short survey over factors influencing protein quality.

Chapter five deals with the methods for determining the feed constituents. Particular importance is placed on the determination of variation-coefficients of digestibility. It illustrates, through an example, how it is possible to determine the digestibility of roughage with the help of laboratory tests.

Chapter six describes the estimations of energy requirements for farm animals. It is a great help for those who work out feeding standards.

Chapter seven reports on the digestibility of protein, its variability and the requirement of protein for farm animals.

Chapter eight gives a short survey of the requirements of minerals, vitamins and antibiotics for farm animals.

Chapter nine presents the feeding standards. It calls attention to many new points of view. It is especially remarkable for ascertaining, that the total nutrient requirement of farm animals is in close correlation with the level of energy consumption. For this reason it is necessary to take this fact into consideration while determining the feeding standards. It is noteworthy that in Hungary the introduction of the concept of protein concentration complies with this requirement.

Chapter ten shows the method of classification of feeds according to their nutritional properties and gives the variability of their chemical compositions.

Chapter eleven describes the basal or energy-rich feeds and in this connection it deals with the concept and significance of bulk.

Chapter twelve characterizes the protein-rich feeds and their features.

Chapter thirteen illustrates the most important knowledge concerning vitamins, minerals and miscellaneous feed additives.

Chapter fourteen discusses information over forages and roughages. It draws attention, that the best method of estimating the value of roughage is the determination of the daily voluntary intake by the animal. It introduces the concept of nutritive value-index, which consists of the multiplication of the relative feed intake and the digestibility of the same feed. This is in close correlation with the weight-increasing value of Prof. Baintner.

The section IV of the book (i.e. the next six chapters), deals with the composition of meal-mixtures. We can find very valuable data in this section for preparing industrial meal-mixtures and set up flexible formulae for large-scale industries.

Chapter fifteen calls attention to the fact, that most of the animals are not fed individually, but they get a specified meal-mixture and they themselves determine voluntarily the quantity to be consumed. Therefore feed- or meal-mixtures should be prepared only on the basis of instructions for feeding standards. For this transformation we can find directions here.

Chapter sixteen teaches us how to prepare so-called flexible meal-mixture formulae. The authors show what quantities can be used or in what quantities are the feeds of certain feeding groups interchangable while preparing meal-mixtures for the specified animal categories.

Chapter seventeen presents the preparation of mixed mineral supplements.

Chapter eighteen describes separately the flexible formulae of meal-mixtures for cattle and sheep, taking into consideration the nutrient value of roughage and succulents that must be supplemented.

Chapter nineteen shows examples of flexible formulae for swine meal-mixtures.

Chapter twenty reports on preparation of meal-mixture formulae with linear programming. It gives the explanation of the mathematical technique, but it is more important, that the authors draw attention to rules and conditions that should be kept in mind while feeding the data into the computer and also while programming.

Chapter twenty-one shows the newest American NRC standards and gives some guiding principles for preparing rations.

Chapter twenty-two introduces the Canadian and North-American legislations regarding feedstuff-trade.

The first part of appendix shows in a table the metabolism of animals of various bodyweights. Further we can find tables of conversion from English and American measuring system to metric-system.

The second part of appendix gives in a glossary the second part of abbreviations used in the book, and further gives detailed explanation of the expressions useful for describing and processing feedstuffs. This part is very useful for those also, who translate English technical texts into Hungarian.

The third part of appendix describes the composition of more than 1000 feedstuffs with reference to fresh- and dry matter content. Besides the chief constituents we can find the mineral-, vitamin- and amino-acid content and also digestibility with regard to different groups of animals where data are available. Likewise it is very important for us, that the data are given without exception in metric-system.

The book contains so many valuable informations and figures that it is not possible to appreciate it appropriately in such a short review. All experts who deal with feeding may read it with advantage.

K. BAINTNER

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ИССЛЕДОВАНИЕ ФИТОМАССЫ НА СОЛОНЦОВОМ ПАСТБИЩЕ (Achilleo-Festucetum pseudovinae)

И. МАТЕ, И. ПРЕЧЕНИ

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Й. МАРКУШ, АБД ЭЛЬ МЕГИД ДАРВИШ

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ВЛИЯНИЕ КИНЕТИНА НА НАКОПЛЕНИЕ ПИПЕКОЛИНОВОЙ КИСЛОТЫ В ИЗОЛИРОВАННЫХ ЛИСТЬЯХ

Л. ДЕЖИ, Г. ПАЛФИ

Авторы искали связь между концентрацией общего белка, всех аминокислот и содержанием пипеколиновой кислоты в листьях фасоли, табака и подсолнечника. С целью изучения листья были изолированы, и половина их помещена в водопроводную воду, а другая половина — в раствор кинетина на 6 дней. Контролем служили листья, оставшиеся на побеге. Данные опыта показали, что вследствие изоляции количество общего растворимого белка уменьшилось, концентрация всех аминокислот — особенно количество аспарагина и глутамина, — повысилась, в то же время среди аминокислот появилась и пипеколиновая кислота. В изолированных, но не обработанных кинетином листьях содержание протеина не уменьшилось, оно даже превзошло количество растворимого белка контрольных листьев. Содержание аминокислоты уменьшилось, в листьях этого варианта так же как и в контроле пипеколиновая кислота не была обнаружена. На основе результатов можно определить, что появление в надземных органах пипеколиновой кислоты, сигнализирующей об интенсивном распаде белка, указывает на то, что роль гормонической регуляции корней, и синтез материалов кинетиновой природы каким-то образом задерживаются.

РОСТ ПЫЛЬЦЕВОЙ ТРУБКИ БАКЛАЖАНА (Solanum melongena L.) in vivo и in vitro

ДЙ. ПАЛ, Е. ОЛАХ, М. ТАЛЛЕР

Если начиная с момента искусственного опыления часть столбика отрезается в разное время, то по количеству семян в плодах можно сделать заключение о скорости движения оплодотворяющей частицы пыльцевой трубки. А путем проращивания пыльцы in vitro можно определить скорость линейного роста пыльцевой трубки, длину пыльцевой трубки, содержащей протоплазму опорожненного пыльцевого зерна, а также расположение оплодотворяющих частиц в пыльцевой трубке, при помощи окрашивания ацетокармином. Обладая этими данными можно определить скорость линейного роста пыльцевой трубки. Сравнивая величину скорости линейного роста пыльцевой трубки при условии in vivo и in vitro оказалось, что при условии in vivo скорость роста пыльцевой трубки почти три раза больше, чем при условии in vitro.

ГОДИЧНОЕ ИЗМЕНЕНИЕ ДИНАМИКИ АКТИВНОСТИ КАТАЛИЗЫ В ВЕГЕТАТИВНЫХ ЧАСТЯХ ЯБЛОНИ

Й. САЛАИ

Используя газометрический прибор Френьо в полевых условиях в течение длительного времени определялась активность каталазы яблони в флоэмной части камбия и в листьях в различные периоды дня. При появлении листьев активность флоэмы-камбия и листьев была высокой. Активность катализы была наиболее высокой в конце августа и начале сентября; наименьшей в конце мая и июне. Измерение ативности каталазы листьев в различное время показало, что существует разница в активности у нижних, средних и верхних ярусов листьев. Обычно одновременно со старением снижается активность каталазы листьев, в то время как во флоэмной части камбия она возрастает. В пределах сорта активность каталазы во флоэмной части камбия достигает минимума в январе и феврале, а максимума — в июле, августе. Разница между максимумом и минимумом 6—9-кратная. Показатель активности каталазы наиболее низкий утром, наиболее высокий днем и вечером. Основываясь на активности каталазы не удалось отделить сорта друг от друга.

КЛАССИФИКАЦИЯ БЫКОВ-ПРОИЗВОДИТЕЛЕЙ С ПОМОЩЬЮ ИСПЫТАНИЯ ИХ ПОТОМСТВ

А. ХОРН, Й. ДОХИ

Авторы изучали потомство 44 быков-производителей датской красной породы в Дании, а также потомство 5 помесных быков (F_1): венгерская пестрая порода x jersey в Венгрии, для того, чтобы определить: изменяется ли — и если да, то в какой мере — классификация быков, если среди их потомства самых слабых по производительности животных одинаково и в определенной мере оставим без внимания, т. е. допустим их выбраковку. Установлено, что в некоторых группах потомства допустима одинаковая выбраковка 10—20 процентов самых слабых по производительности животных в любое время, без того, чтобы потерпеть ущерб в возможности познаваемости быков-производителей, имеющих либо выдающееся улучшающее, либо в большой мере ухудшающее влияние.

ВЛИЯНИЕ РАЗМЕРОВ ПОЛЯ, ГУСТОТЫ ТРАВОСТОЯ И ФАЗЫ ЦВЕТЕНИЯ НА ОПЫЛЯЮЩИХ ЛЮЦЕРНУ ДИКИЕ ПЧЕЛЫ

П. БЕНЕДЕК

На основании опытов удалось выработать приемный метод, служащий для получения почти статического результата. Отечественный метод исследования, применявшийся ранее, не исключал влияния, вызванного интенсивным движением опылителей; поэтому результаты этих двух методов различаются между собой, но с помощью таблицы возможно их сравнение. Густота диких пчел на необольших полях люцерны только на немного

больше, чем на больших полях. Количество пчел у видов с коротким роением меньше; обилие их у остальных групп немного больше или такое же как на больших, так и на малых полях люцерны. На полях люцерны с большим травостоем меньше опылителей, чем на менее загущенных полях. Количество пчел в группе с коротким роением почти не показывает разницы на полях с различным травостоем, в то время как обилие других групп гораздо меньше на полях с более густым травостоем. Число опылителей больше всего в период наибольшего цветения; количество групп роения связано с интенсивностью роения.

ИЗУЧЕНИЕ СОСТАВНЫХ ЧАСТЕЙ ЗОЛЫ ДРЕВЕСНЫХ И ТРАВЯНИСТЫХ РАСТЕНИЙ, ПРОИЗРАСТАВШИХ НА КИСЛЫХ ПЕРВИЧНЫХ ПОРОДАХ И НА ЩЕЛОЧНЫХ ГОРНЫХ ПОРОДАХ

Д. ТЁЛДЯШИ, И. ЧАПОДИ, Л. БЭНЦЕ

Авторами изучен минеральный состав лесных растений, происходящих из двух зон, которые находятся на небольшом расстоянии друг от друга. Анализ растений, произраставших на кислых и более или менее подзолистых почвах, сформированных на прочных гнейсах, слюде и сланцах основных пород Шопронского горного района, показал, главным образом, лёгкое поглощение растениями калия, фосфора, цинка и меди. С другой стороны, в **rendzina** и **Ramann-** коричневых почвах, сформированных на известняке **Laitaicum** и песке морского происхождения, содержится кальций и молибден, что указывает на благоприятную возможность поглощения этих элементов. Авторы упоминают о представлении, которое должно быть учтено при составлении плана использования района. Авторы обращают внимание на неблагоприятно высокое соотношение Ca/P и неблагоприятно низкое соотношение **Cu/Mo** в растениях, произрастающих на **Laitaicum.** Кроме того, абсолютное количество марганца и меди не достигает оптимального уровня, который должен быть в корме травоядных животных.

КОМПЛЕКСНОЕ ДЕЙСТВИЕ ИРРИГАЦИИ, ЗЕЛЁНОГО УДОБРЕНИЯ И ВЫСОКОЙ НОРМЫ УДОБРЕНИЯ НА ВИНОГРАДНИКИ, РАСТУЩИЕ НА ПЕСЧАНЫХ ПОЧВАХ

Й. ФЮРИ

Было исследовано комплексное действие ирригации, зелёного удобрения и высокой нормы удобрения на виноградники, растущие на песчаных почвых. Результаты двулетних исследований (1965—1966) показали, что ирригация (И) и удобрение (У) даже раздельно дали статистически доказанный положительный эффект на массу урожая. В случае комбинированной обработки (И + У) этот эффект, несмотря на отсутствие достоверных различий, показал тенденцию увеличения. С другой стороны, применение зелёного удобрения даёт значительную прибавку урожая только тогда, когда применяли комбинированную обработку ирригацией и удобрением (И + У + З). Но когда давали одно лишь зелёное удобрение или зелёное удобрение с ирригацией (И + З), количество урожая в этом случае едва отличалось от контроля. Таким образом, зелёное удобрение целесообразно использовать (и это было соответственно сделано) только тогда, когда оно применяется совместно с удобрением. Качество урожая улучшилось только при применении ирригации и связанных с нею обработок. Это незначительное улучшение может быть более видимым, а также достоверным, особенно тогда, когда имеются данные о содержании сахара, выраженные в центнерах на кадастральный хольд (Таблица 4).

ВЛИЯНИЕ ФУНГИЦИДОВ, ПРИМЕНЕННЫХ ПРИ ЦВЕТЕНИИ ЯБЛОНИ ЙОНАТАН, НА ПРОРАСТАНИЕ ПЫЛЬЦЫ И ЗАВЯЗЫВАНИЕ ПЛОДОВ

Ж. ДАНЧ, А. КИШ

В лабораторных и полевых условиях изучалось влияние опрыскивания фунгицидами при цветении на прорастание пыльцы и завязывание плодов, а также и на урожай яблони Йонатан, т. е. не оказывает ли опрыскивание вредного влияния. Если пыльца цветков яблони непосредственно соприкасается с фунгицидами, после 24 и 48 часового прора-

стания они не показывают значительного прорастания. В полевых условиях пыльца, собранная через 24 часа после опрыскивания, прорастала при всех обработках фунгицидами. Результаты наших опытов показывают, что опрыскивание некоторыми средствами во время цветения снижает завязывание плодов, что связано с задержкой прорастания пыльцы. Задерживающее влияние фунгицидов частично или совершенно выравнивается метеорологическими условиями и удлинением сроков раскрытия пыльников, поэтому нет снижения в урожае, наоборот, наблюдается его повышение. Увеличение урожая связано с фунгицидным эффектом примененного средства защиты растений.

УСТОЙЧИВОСТЬ СЕМЯН CONVOLVULUS ARVENSIS К РАЗНЫМ ГЕРБИЦИДАМ

Дь. ЦИМБЕР

Среди сорняков полевых и садовых культур венгерского сельского хозяйства *Convolvulus arvensis* L. занимает первое место по оказываемым им вредному действию. Несмотря на широкое применение гербицидов он оттеснялся только в незначительной мере даже в некоторых культурах он стал резистентным к хлораминотриазинам, использованным продолжительно. Одной из причин его распространения оказалась твердость семенной оболочки на 90—96%, вследствие чего семена могут лежать в почве годами, становясь источниками повторных заражений. Из-за непроницаемости семенной оболочки — пока оболочка не растворится в результате влияния почвенных факторов, — они оказываются устойчивыми к разным гербицидам, что было подтверждено в полевом опыте автора в 1967-м году при применении 1 и 3 процентного раствора Крезонит Е, 1 процентного раствора Хунгазин ПК и К 64, в 1968-м году при применении 3 процентного раствора Кармекс (при опрыскивании поверхности почвы), при применении введенного в почву 1 процентного раствора Авадекс (Diallate) и Авадекс BW (Triallate), а также при применении этих же гербицидов в лабораторных опытах. В программе уничтожения сорняков в будущем необходимо обратить особое внимание на **Convolvulus** и на другие сорняки, обладающие твердой семенной оболочкой.

ВЛИЯНИЕ ЗАВИСИМОГО ОТ КАТИОНА ХЛОРИДА НА ФИКСАЦИЮ ФОТОСИНТЕТИЧЕСКОЙ УГЛЕКИСЛОТЫ

Л. ХОРВАТ, Б. И. ПОЖАР

Чистый для анализа хлорид калия, а также чистый для анализа и чистейший хлорид аммония стимулируют интенсивность фиксации фотосинтетической углекислоты, в то время как чистый для анализа хлорид натрия и техн. хлорид аммония задерживают ее по сравнению с контролем, обработанным дестиллированной водой. Во влиянии зависимого от катиона хлорида величина гидратной оболочки катиона играет, наверно, более важную роль чем ионный радиус катиона. Значит, именно натрий, а не хлорид или сцепленный с ним аммоний развивает задерживающий эффект на метаболизм растений.

ИЗУЧЕНИЕ ВЕСА ПРОРОСТКОВ И АКТИВНОСТИ ЭНДОГЕННОЙ ДЕГИДРОГЕНАЗЫ У ИНЦУХТИРОВАННЫХ ЛИНИЙ, А ТАКЖЕ У ПРОСТЫХ И ДВОЙНЫХ ГИБРИДОВ КУКУРУЗЫ

Ш. ГАШПАР

В ходе опытов установлено, что в проростках простых и двойных гибридов формазана больше, чем у их родителей. Вес проростков гибридов тоже был большим, чем у их родителей. Найдена тесная положительная корреляция ($r = +0{,}774$ или $r = +0{,}981$) между образованием формазана и отношением веса побега к корню у простых и двойных гибридов. У инцухтированных линий такой корреляции не удалось обнаружить. По мнению автора изучение отношения веса побега к корню, а также образование формазана в молодых проростках можно применить для предварительного лабораторного отбора гибридов, обладающих хорошей комбинационной способностью.

ЧИСЛО ХРОМОСОМ И КАРИОТИПЫ В РОДАХ CROTALARIA И SESBANIA

Р. М. ДАТТА, А. К. НЕОГИ

Были установлены определенные различия между кариотипами трех изученных видов *Crotalaria*. Найдено 5 типов хромосом у *C. rotundicarinata* Baker, 4 типа у *C. retusa* L. и только 3 типа у *C. dissitiflora* Benth. Хромосомы у *C. dissitiflora* Benth. были сравнительно длиннее, чем у *C. retusa* L. и *C. rotundicarinata* Baker, у *C. dissitiflora* Benth. встречалось две пары хромосом, с вторичными перетяжками, у *C. rotundicarinata* Baker отмечена одна пара, а у *C. retusa* L. не было хромосом с вторичными перетяжками. У *C. retusa* L. были найдены 5 пар хромосом с медиальной перетяжкой, одна с субмедиальной, одна с субтерминальной и одна с почти медиальной. У *C. rotundicarinata* Baker из 9 перетяжек 3 имели субтерминальное положение, 3 — субмедиальное, 2 — медиальное и только одна почти медиальное, в то время как у *C. dissitiflora* Benth. 9 имели субтерминальное положение и 3 субмедиальное. Число хромосом у *C. dissitiflora* Benth. 2n = 20 является новшевством. В роде *Sesbania* у *S. paludosa* Prain наблюдалось 5 типов пар хромосом, у *S. sesban* L. только 4 типа. Длина хромосом у обоих видов была почти одинаковой. Оба они имеют только одну пару хромосом с перетяжкой. У *S. sesban* L. из 7 перетяжек 4 имели субтерминальное положение, 2 — субмедиальное и только одна — медиальное, в то время как у *S. paludosa* Prain. 3 имели субтерминальное, 2 — субмедиальное, одна — почти медиальное и одна медиальное положение. Число хромосом у *S. paludosa* Prain. 2 n=12 является новым числом.

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Fasc. 1—2

VARIA

FORUM

LECTIONES

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RECENSIONES

Fasc. 3—4

VARIA

FORUM

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CHRONICA

RECENSIONES

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PHYTOMASS STUDIES OF SALT PASTURES (ACHILLEO-FESTUCETUM PSEUDOVINAE)

By

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From the point of view of pasture management saline pastures with *Achilleo-Festucetum pseudovinae* have considerable acreage in Hungary. Within the frame of the International Biological Program the phytomass production of this ecosystem and its changes as depending on the phenophase, on the one hand, and yield trends of grazed and non-grazed areas, on the other, were studied. Green- and dry yields, production rate, turnover, productivity, caloric- and ash components changes of the leading grass species *(Festuca pseudovina)* of the pasture were subjected to detailed studies.

Introduction

One of the areas studied at Újszentmargita within the frame of the International Biological Program (IBP) was a highly degraded pasture with *Achilleo-Festucetum pseudovinae*. When reporting on our pilot experiments performed in the first year (1966) we gave a general characterization of this pasture too (MÁTHÉ—PRÉCSÉNYI—ZÓLYOMI 1967, MÁTHÉ—TALLÓS 1967, PRÉCSÉNYI 1967). Present study includes a comparison of the phytomass production of the pasture, the role of the *Festuca pseudovina* phytomass and some findings concerning the ecosystem of the pasture.

Material and Method

The intensively grazed land was botanically characterized partly in the papers mentioned above and, in details — as related to the whole area of the Hortobágy — in Soó's studies (1933, 1947). Mainly on the alkali area of the Trans-Tisza it represents extensive pastures of high acreage in a mosaic-like pattern.

A highly up-to-date and detailed survey of the weather conditions of this area of Hortobágy Puszta and of the microclimatological data obtained at Újszentmargita is available (BERÉNYI 1963, 1965). Our phytomass data originate from that very part of the pasture where a temporary meteorological station is operating.

Soil testing data on saline pastures of such character in the Hortobágy are frequent in the literature; e.g. in papers by ARANY (1926), MAGYAR (1928), STOCKER (1930), MÁTHÉ (1933), SZABOLCS (1954), STEFANOVITS (1963) etc.

In 1967, 32 cutting samples of 10×10 cm and 8 soil monolith samples of 1 dm^3 per each (to a depth of 0—10 cm) were taken during the months of observation. In 1968 the number of samples was reduced while their size increased (PRÉCSÉNYI 1968), so we worked with 8 cutting samples of 20×10 cm and 8 soil monolith samples of 1 dm^3 per each. The enclosed area of the meteorological field station made it possible to assess the yield of a non-grazed phytomass produced actually on the spot. Our standing crop data are given as related to 1 m^2 of phytomass dried at a temperature of 105 °C.

Underground parts of plants were obtained from the soil samples by repeated washing and sedimentation. The underground phytomass was not divided into living and non-living plant parts, it was treated as a whole and dried at 105 °C before weighing. (With weights of underground parts certain weight surplus should undoubtedly be reckoned with owing to the soil particles that could not be removed by washing and sedimentation; further, the fact that stubbles left behind after cutting at a height of 1—1.5 cm were included in the underground phytomass of the monolith should also be taken into consideration.)

Results

Plant mass cut along with intensive grazing and its monthly variation are shown in Table 1 summarizing data obtained in 1967. The table presents further the weights of underground plant parts (both liv ing and dead) taken from the upper 10 cm soil layer and related to 1 m².

As it is seen from the table *Festuca* was dominating throughout the whole year (76.9—91.7 per cent). Among the "Other species" the species of *Achilleo-Festucetum pseudovinae* in the aboveground part of the phytomass play more important role (MÁTHÉ 1967, 1968) from the point of view of early spring (geophytons) and autumn aspects (hemi-cryptophytons, e.g. *Achillea, Limonium* etc.). Besides, mosses are present in certain months in considerable amounts.

During 1968 cutting and soil monolith samples directly comparable with, and taken at the same time as those in the previous year were taken only on three occasions (April, June, September). Their data are presented in Table 2.

This year (1968) pastures showed a high rainfall deficiency as early as in April — monthly precipitation was 16 mm, while in the previous year it was

Table 1

Weights of above- and underground parts of vegetation
1967

Time of sampling	Aboveground mass						Underground mass g/0.1 m³
	Festuca pseudovina		Other species		Total weight		
	g	%	g	%	g/100 cm²	g/1 m²	
March 22	1.2	80.0	0.3	20.0	1.5	150	1520
April 20	1.7	85.0	0.3	15.0	2.0	200	1580
May 23	1.7	89.5	0.2	10.5	1.9	190	1330
June 20	1.7	89.5	0.2	10.5	1.9	190	1480
July 20	1.2	85.7	0.2	14.3	1.4	140	1510
August 18	1.1	91.7	0.1	8.3	1.2	120	1550
September 22 .	0.7	77.8	0.2	23.2	0.9	90	1210
October 20	1.0	76.9	0.3	23.1	1.3	130	850
Year's average	1.3	86.7	0.2	13.3	1.5	150	1379

Table 2

Weights of above- and underground parts of vegetation
1968

Time of sampling	Aboveground mass						Underground mass g/0.1 m³
	Festuca pseudovina		Other species		Total weight		
	g	%	g	%	g/200 cm²	g/1 m²	
April 19	1.0	58.8	0.7	41.2	1.7	85	980
June 20	2.8	82.3	0.6	17.7	3.4	170	930
September 19 ..	1.7	73.9	0.6	26.1	2.3	115	1090
Year's average	1.8	75.0	0.6	25.0	2.4	123	1000

Table 3

Aboveground phytomass weight of Achilleo-Festucetum pseudovinae, 1968
(ungrazed area)

Time of sampling	Aboveground part	Average g /4 dm²	Average g/ 1 m²	Percentage share
April 19	*Festuca pseudovina*	8.5	215	72.9
	Other species	2.6	65	22.0
	Moss	0.6	15	5.1
	Total	11.7	295	100.0
May 16	*Festuca pseudovina*	7.7	193	72.6
	Other species	2.9	72	27.4
	Total	10.6	265	100.0
June 20	*Festuca pseudovina*	11.0	275	60.8
	Other species	6.4	160	35.4
	Moss	0.7	17	3.8
	Total	18.1	452	100.0
July 17	*Festuca pseudovina*	7.5	188	70.7
	Other species	3.0	75	28.3
	Moss	0.1	2	1.0
	Total	10.6	265	100.0
Sept. 19	*Festuca pseudovina*	9.1	228	84.3
	Other species	1.7	42	15.7
	Total	10.8	270	100.0
Oct. 24	*Festuca pseudovina*	9.1	228	91.0
	Other species	0.8	20	8.0
	Moss	0.1	2	1.0
	Total	10.0	250	100.0

Analysis of variance

Source of variability	SQ	df	MS
Time of sampling	131.71	5	26.37**
Error	57.09	12	4.75
Total	188.80	17	

Comparison of mean values

Time of sampling	IV	V	VI	VII	IX	X
Mean	11.7	10.6	18.1	10.6	10.8	9.9
		LSD	5 % =	3,84		
			1 % =	5,41		
			0,1 % =	7,64	g/4 dm^2	

23 mm —, grazing and trampling became more intensive, consequently not only the aboveground phytomass — that can be assessed totally — but also the leading grass, *Festuca* decreased considerably. Since the subsequent months were also poor in precipitation — the total precipitation of May and June was 40 mm as compared to the 105 mm in the previous year (1967) — not only the aboveground plant parts but also the phytomass reserve of the upper soil layer and even its formation decreased. Species proportions and weight proportions of plants left on the pasture were also modified by the drought (less mosses, less *Festuca*, etc.).

The actual aboveground phytomass production of the pasture in 1968 is shown in Table 3. Data were obtained from the area preserved from grazing.

If the weight data of this table are compared to those of Table 4, we get information about the amount of hay grazed, that is, the amount that could be grazed.

Monthly changes in the efficiency of the stand on the non-grazed area in 1968 are shown in Table 5.

Global radiation values originating from measurements made by Prof. D. Berényi 4.4 Kcal/g was used as the caloric factor of green weights on the basis of our own investigations.

On the basis of Table 6 productivity changes of grazed and non-grazed lands can be compared.

Table 4

Phytomass weight of grazed and non-grazed areas, and the amount of hay recovered by grazing (1968)

Time of sampling	Pasture g/1 m²	Non-grazed area g/1 m²	Grazed amount	
			g/1 m²	%
April 20	90	295	205	69
May 16	50	265	215	81
June 19	170	452	287	63
July 17	10	265	255	96
September 19	120	270	150	55
October 24	20	250	230	92
Year's average	76	299	223	75

Table 5

Changes in the efficiency of Achilleo-Festucetum pseudovinae in 1968 non-grazed area

Month	Total radiation Kcali/4 dm²	Caloric value of the crop Kcal/g/4 dm²	Efficiency %
April	4280	51.5	1.2
May	5080	46.6	0.9
June	5680	79.6	1.4
July	6120	46.6	0.7
Sept.	2440	47.5	1.9
Oct.	2600	43.5	1.6
		Mean:	1.2

From this table the productivity of grazed lands in 1967 and 1968 can also be compared, with the different weather conditions taken into consideration. Data of grazed and non-grazed lands seemed to be highly parallel in 1968.

The rate and time of turnover of the green crop were somewhat higher, and more rapid on grazed lands than on non-grazed ones in 1966 (Table 7), although our estimation was only approximate owing to the low number of samples taken.

The subsequent, and more detailed discussion of the role played by *Festuca pseudovina* in the phytomass justifies the fact that it is the leading plant of the examined pasture and the most important one from the point

Table 6

Productivity of grazed and non-grazed lands
(g/m²/day)

Grazed area					Non-grazed area
Number of days between dates of sampling	Living above-ground parts 1967	Underground parts	Number of days between dates of sampling	Living above-ground parts 1968	Living above-ground parts 1968
III—IV 29	1.724	2.068			
IV—V 33	—0.303	—7.575	IV—V 28	—1.428	—1.071
V—VI 28	0.000	5.357	V—VI 35	3.428	5.342
VI—VII 30	—1.666	1.000	VI—VII 27	—5.925	—5.342
VII—VIII 29	—0.689	1.379	VII—	1.746	0.079
VIII—IX 35	—0.857	—9.714	IX 63		
IX—X 27	1.481	—13.333	IX—X 36	—2.777	—0.555

Table 7

Turnover ratio (a) and -time (b)

		Green mass	*Festuca pseudovina*
Grazed area	67 a	55%	58%
	b	1.81	1.72
	*68 a	50%	64%
	b	2.00	1.56
Non-grazed area	68 a	41%	31%
	b	2.43	3.22

* Data originate from three measurements

of view of pasture management in the Hortobágy. Its quality and yield is in close correlation with its ecological conditions. Its phenophase changes over two years (1967, 1968) are shown in Figure 1 reflecting also the differences in weather between the two years.

The decreasing effect of drought on the green weight of *Festuca pseudovina* was felt in 1968 first of all on grazed lands. On non-grazed lands the green weight of *Festuca* remained constantly at about the same level (Table 8).

The caloric values of green ("living" when samples taken) and browned ("non-living" when sampled) parts of *Festuca pseudovina* are included in Table 9.

Table 8

Green weight of Festuca pseudovina on non-grazed area
1968

Analysis of variance

Source of variability	SQ	df	MS
Time of sampling	23.65	5	4.73^{NS}
Error	53.16	12	4.43
Total:	76.81	17	

Comparison of mean values

Time of sampling	IV	V	VI	VII	IX	X
Mean	8.6	7.7	11.0	7.5	9.1	9.1

LSD 5% 3.7 g/4 dm^2

Table 9

Caloric values of living and non-living aboveground mass of Festuca pseudovina as related to 1 g dry matter

	Living		Non-living	
	Kcal/g	Average Kcal/g	Kcal/g	Average Kcal/g
Festuca pseudovina	4.56		4.06	
	4.46		4.15	
	4.47	4.41	4.16	4.08
	4.30		4.09	
	4.27		3.96	

[Mean values of the table were obtained by summarizing the Festuca material of the reaped samples of 1968 (April, June and September) and then, after dividing it into living and non-living parts, averaging the obtained values of 5 calorific measurements per each.]

There was a highly significant difference in ash content between "living" and "non-living" parts, as it is shown by Table 10.

More detailed examinations and evaluations of changes in caloric values were carried out with reaped samples taken in 1967. This time, however, the phytomass of *Festuca pseudovina* was not separated into "living" and "non-

Table 10

Ash contents of the living and non-living aboveground mass of Festuca pseudovina

	Living		Non-living	
	%	mean	%	mean
Festuca pseudovina	7.56		13.81	
		7.45		13.49
	7.34		13.18	

Table 11

Caloric values of Festuca pseudovina, 1967

Time of sampling	Non ash-free	Ash-free
March 21	3.88	4.67
	3.38	4.45
April 20	4.32	4.96
	4.39	5.12
May 23	4.70	5.29
	4.53	5.17
June 20	4.57	5.29
	4.41	5.01
August 17	3.64	4.48
	3.53	4.17
September 22	4.00	5.02
	3.32	4.77
October 19	3.75	4.72
	3.52	4.58

Analysis of variance
non ash-free

Source of variability	SQ	df	MS
Time of sampling	2.6924	7	0.3846**
Error	0.6362	8	0.0795
Total:	3.3286	15	

Comparison of mean values
non ash-free

Time of sampling	III	IV	V	VI	VII	VIII	IX	X
Mean	3.63	4.35	4.61	4.49	4.22	3.58	3.66	3.63

LSD 5% = 0.65
1% = 0.94
0.1% = 1.42

Analysis of variance
ash-free

Source of variability	SQ	df	MS
Time of sampling	1.3589	7	0.1941*
Error	0.4390	8	0.0548
Total:	1.7979	15	

Comparison of mean values
ash-free

Time of sampling	III	IV	V	VI	VII	VIII	IX	X
Mean	4.56	5.04	5.23	5.15	4.98	4.32	4.89	4.65

LSD 5% = 0.54
1% = 0.78
0.1% = 1.18

living" material. Caloric values as well as their variance analysis and mean value comparison are given in detail in Table 11.

As it can be seen significant differences between the monthly averages were more often found with the non-ash-free caloric values than with the ash-free caloric values.

Changes in caloric values during the year of investigation are also shown in Fig. 2. It reflects well the relation with the various states of phenophasis that was observed by many authors (LONG 1934, OVINGTON—LAWRENCE 1967, KIECKHEFER 1962, etc.). (Fig. 2 shows not only the mean values of Table 11 but also the fluctuations of data deviating from the average.)

The production rate of *Festuca pseudovina* on grazed and non-grazed lands is presented in Table 12 which shows that the production rate of non-grazed lands is lower than that of grazed ones.

Table 12

Production rate of Festuca pseudovina
(cumulative percents)

Time of sampling	Grazed area (1967)		Non-grazed area (1968)
III.	11.6		
IV.	28.1	(21.2)	16.2
V.	44.6	(42.4)	30.7
VI.	61.1	(63.6)	51.4
VII.	72.7	(78.6)	65.5
VIII.	83.3		
IX.	90.0	(87.3)	82.6
X.	99.7	(99.8)	99.7

Figures in brackets show the percentage of cumulative values obtained by omitting from the data of 1967 those months which are not included in the data of 1968.

Table 13

Productivity of Festuca pseudovina on grazed and non-grazed areas

Number of days between dates of sampling	Grazed area 1967 g/100 cm²/day	Number of days between dates of sampling	Non-grazed area 1968 g/100 cm²/day
III—IV 29	0.017		
IV—V 33	0.000	IV—V 28	—0.008
V—VI 28	0.000	V—VI 35	0.023
VI—VII 30	—0.016	VI—VII 27	—0.032
VII—VIII 29	—0.0003	VII—IX 63	0.006
VIII—IX 35	—0.011		
IX—X 27	0.011	IX—X 36	0.000

As to the productivity of the species (*Festuca pseudovina*), there is hardly any difference between the two areas, as can be seen in Table 13.

This phenomenon can be partly explained by the different meteorological conditions and partly by the fact that the non-grazed area was preserved from grazing over a year only.

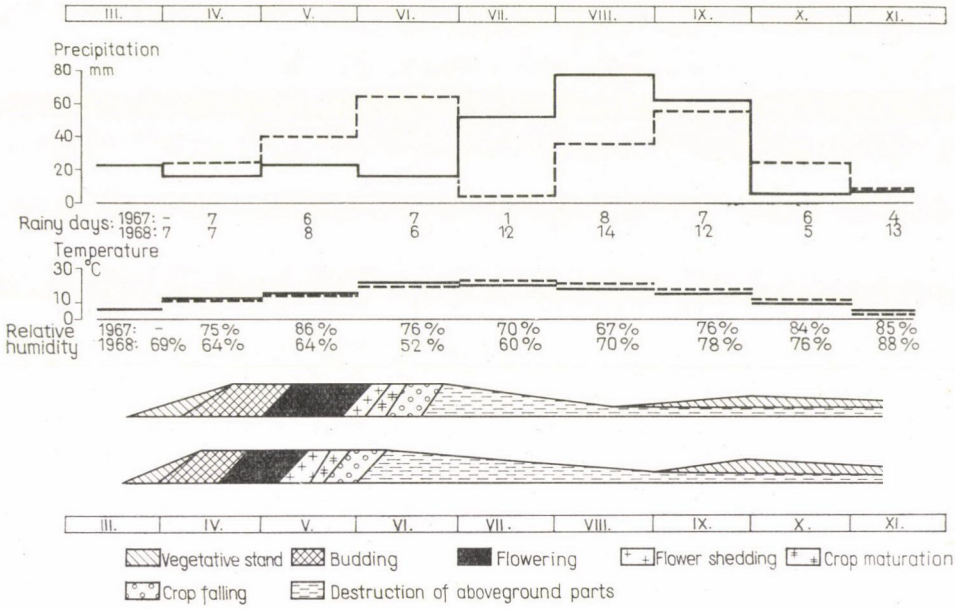

Fig. 1. Phenological spectrum of *Festuca pseudovina* (With meteorological data obtained at Újszentmargita ------- 1967, ——— 1968)

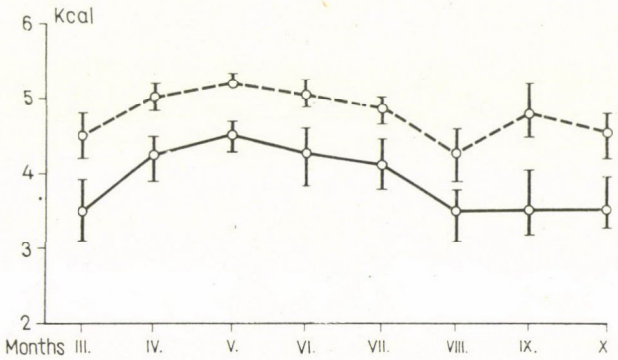

Fig. 2. Caloric value changes in the aboveground phytomass of *Festuca pseudovina* (—— values related to 1 g dry matter, ----to 1 g ashfree dry matter, with dispersion amplitude)

As to the percentage and time of turnover material Festuca showed a slower rate and, accordingly, a longer time of exchange on the non-grazed area than it did on the grazed one (Table 7).

Conclusions

It is the species *Festuca pseudovina* that dominates in the phytomass weight of *Achilleo-Festucetum pseudovinae* pastures, the extensive grazing lands all over the country making up about 80 per cent of the average of the growth season.

A comparison of the hay yield of non-grazed and intensively grazed pastures showed that about 55—96 per cent of the total aboveground phytomass could be consumed by animals. (The rest of the phytomass consists of stubbles, a material bound to be decomposed or decayed in proportions varying from season to season.)

Phenophase differences between the crop years, which depend on weather conditions manifest themselves to a high extent in both amount (changing yields) and quality (calorific value differences) of the phytomass.

Drought has a higher effect on grazed lands than on non-grazed lands.

Turnover rate and -time of the green phytomass is higher and shorter respectively on grazed lands than on non-grazed ones; production is slower and exchange takes more time on the latter.

Fluctuation of the efficiency value in the course of the year is 0.7—1.9 per cent on the non-grazed area.

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REFERENCES

Arany, S. (1926): A hortobágyi ősi szikes legelőkön végzett talaj felvételek (Soil tests performed on the ancient saline pastures of the Hortobágy Puszta). Kísérl. Közl., **29,** 48—70.

Berényi, D. (1963): Mikroklimatológiai megfigyelések a Hortobágyon 1961. és 1962. években (Microclimatological observations on the Hortobágy Puszta in 1961 and 1962). Acta Univ. Debr. Meteorologica, **9/2,** 4—28.

Berényi, D. (1965): Mikroklimatologische Beobachtungen und Wärmehaushaltmessungen auf der Hortobágy-Puszta (Heide) bei Debrecen. Angewandte Meteorologie, **5,** 87—91.

Kieckhefer, J. B. (1962): Correlation between phenology and caloric content in forest herbs. Trans. Ill. Acad. Sci., **55,** 215—223.

Long, F. L. (1934): Application of calorimetric records to ecological research. Plant Physiol., **9,** 323—337.

Magyar, P. (1930): Növényökológiai vizsgálatok szikes talajon (Phytoecological studies of alkali soils). Erd. Kis., **32,** 75—118.

Máthé, I. (1933): A hortobágyi Ohat-erdő vegetációja (Vegetation of the Ohat-forest in the Hortobágy). Bot. Közl., **30,** 163—184.

Máthé, I. (1967): Néhány adat az újszentmargitai erdő fenológiai ritmusához (Contribution to the phenological rhythm of the Újszentmargita forest). Bot. Közl., **54/3,** 185—192.

Máthé, I. (1968): Fenológiai és fitomassza vizsgálatok Újszentmargitán (Phenological and phytomass investigations at Újszentmargita). Bot. Közl., **55/3,** 205—214.

MÁTHÉ, I.—PRÉCSÉNYI, I.—ZÓLYOMI, B. (1967): Phytomass investigations in different ecosystems at Újszentmargita. Acta Botanica Acad. Sci. Hung., **13,** 239—257.
MÁTHÉ, I.—PRÉCSÉNYI, I. (1968): Adatok egy búzatábla fitomassza produkciójához (Data on the phytomass production of a wheat field). Agr. Tud. Közl., **27,** 253—264.
OVINGTON, J. D.—LAWRENCE, D. B. (1967): Comparative chlorophyll and energy studies of prairie, savanna, oakwood and maize field ecosystems. Ecology, **48/4,** 515—524.
PRÉCSÉNYI, I. (1967): Terresztris növényi produkció tanulmányok néhány módszertani kérdése (Some methodological questions of terrestrial plant production studies). Bot. Közl., **54/3,** 167—174.
PRÉCSÉNYI, I. (1969): A növényzet talajszint alatti és feletti részei súlyának aránya néhány rét-legelő társulásban (Weight ratio of underground and aboveground plant parts in some meadow-pasture fitocenosis). Növénytermelés, **18/2,** 49—58.
SOÓ, R. (1933): A Hortobágy növénytakarója (Vegetation of the Hortobágy). Debr. Szemle, **7,** 56—77.
SOÓ, R. (1947): Conspectus des groupements végétaux dans les Bassins Carpatiques. I. Les associations halophiles. Debrecen, 50.
STEFANOVITS, P. (1963): Magyarország talajai (Hungarian soils). Second edition, Akadémiai Kiadó, Budapest.
STOCKER, O. (1930): Über die Messung von Bodensaugkräften und ihrem Verhältnis zu den Wurzelsaugkräften. Zeitschr. f. Bot., **23,** 27—56.
SVÁB, J. (1961): Statisztikai módszerek mezőgazdasági kutatók számára (Statistical methods for agricultural research workers). Mezőgazdasági Kiadó, Budapest.
SZABOLCS, I. (1954): A Hortobágy talajai (Soils in the Hortobágy). Mezőgazdasági Kiadó, Budapest.

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VARIOUS LEVELS OF MANGANESE AND COPPER IN THE RATIONS OF GROWING PIGS

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Concepts of suitable and economic values of manganese and copper supplementation in feeding Hungarian White meat-type pigs starting at 78—155 days of age were extensively studied. Results obtained from this investigation showed that the average daily gain increased progressively with the level of manganese in the ration. There was improvement in feed conversion when 160 ppm manganese was added to the ration, then the increase was 5 per cent higher than the control. Pigs receiving 200 ppm copper supplementation to diet grew faster and feed utilization slightly improved in comparison to those where 100 ppm copper supplementation was given. The relation between age and weight of pigs receiving 160 ppm and 200 ppm copper supplementation was found to be significantly linear.

Introduction

In spite of the small supply in the body, the manganese has several essential functions and is of practical importance in animal nutrition. In several species of animals differences in the manganese contents of diet have been related to various responses including gains of body weight, concentrations of manganese in blood and blood serum, activity of phosphatase in blood, serum and bones, development of the bone composition of soft tissues and metabolism of calcium and phosphorus.

The effects of different dietary levels of manganese are of interest because of the evidence of antagonisms existing between this mineral and other dietary components and because of the reports of extreme and variable concentrations of manganese in forages (BLACKEMORE *et al.* 1937, RUSSEU 1944, BEESON—MATRONE 1950, STUART *et al.* 1950).

HAWKINS *et al.* (1955) found that the rate of growth was significantly greater for calves fed a basal diet with 50 ppm added manganese. ROBINSON *et al.* (1960) reported that the daily gain and feed conversion of beef cattle improved when the ration had been supplemented with 250 ppm manganese.

In contrast, excess dietary manganese has been reported to cause a decrease in growth of rats: BECKER—MCCOLLUM (1938), CHORNOCK *et al.* (1942), HANSARD *et al.* (1960), MOINUDDING—LEE (1960), of chicks: HELLER—PENQUITE (1937), of swine: GRUMMER *et al.* (1950), GENNARD *et al.* (1959), LEIBHOLZ *et al.* (1962) — of calves: CUNNINGHAM *et al.* (1966).

On the other hand, the copper-deficiency anemia may occur at any time of life when the available supply of mineral becomes deficient relative to the

needs for hemoglobin formation. EVVARD *et al.* (1928) reported beneficial response of copper sulfate when used as feed additive for swine ration.

Several attempts have been made in the field of animal nutrition to find out the proper requirement of copper in the diet for growing pigs. It is considered to be necessary to inter-relate the scattered knowledges in order to realize the variations among the wide ranges of recommended values.

SCHURCH (1956) found that the addition of 230 ppm copper to the ration of the pigs increased weight gain and improved feed utilization.

Most workers recommended 250 ppm copper as a level for maximum growth and feed conversion when added to a deficient diet of growing pigs: ALLEN *et al.* (1958), BARBER *et al.* (1961), BUNCH *et al.* (1961), HAWBAKER *et al.* (1961) — LUCAS *et al.* (1961).

In contrast WALLACE *et al.* (1960) reported no marked or consistent improvement of growth or feed efficiency on any level of copper supplementation up to 200 ppm and 250 to 750 ppm were toxicity levels.

In an attempt to throw some light on these problems, an experiment has been undertaken to study the effect of different levels of manganese and copper supplementation to growing-pigs diet on the weight gain and feed utilization.

Material and Method

Eighty Hungarian White pigs were taken from the state farm of Apaj, Hungary. The experimental period was 77 days and started when the pigs were 78 days old in average. The animals were divided into four groups of twenty pigs each (10 males and 10 females) grouped according to weight, sex and litter.

The basal ration fed to all groups contained maize 40 per cent, wheat 30 per cent, dried lucerne 6 per cent and mixture 24 per cent, wheat bran 35 per cent, peanut meal 28 per cent, meat meal 20 per cent. Dried lucerne 3 per cent, flax-grits 3 per cent, limestone 7 per cent, salt 2 per cent and different vitamines 1 per cent. The starch value of the basal ration was 67.12 and crude protein 16.0 per cent.

The protein level of the basal ration was 20.0 per cent adjusted by meat meal at the start of the experiment and gradually decreased. It descended to 16.0 per cent at the end of the experiment.

Food and water were available ad libitum.

Table 1

Daily requirement, daily gain and growth measure of

Periods in weeks	1	2	3	4
Average daily starch value gms	910	910	910	890
Average daily gain gms	279.3 ± 1.01	165.7 ± 0.87	248.6 ± 1.36	435.7 ± 1.56
Growth measure gms s.v.	3.24	5.49	3.66	2.04

Levels from manganese and copper of 40, 100; 80, 100; 120, 200; and 160, 200 ppm were offered to Group I, II, III and IV respectively.

The form of the addition was copper carbonate and manganese oxide.

The animals were individually weighed weekly. The average weight was calculated. The daily gain and growth measure were estimated.

SNEDECOR's book (1956) was consulted for statistical analysis as well as EID's book (1953). Notations were like those of SNEDECOR.

Results

The data in Table 1 show that the starch value consumed daily per head in Group I started by 910 gms and reached 1360 gms.

Averages in daily gain ranged between 165.7 $\pm$ 0.87 gms and 435.7 $\pm$ 1.56 gms. The lowest growth measure was 2.04 gms s.v. and the highest was 5.49 gms s.v.

Table 2 illustrates that the average daily starch value consumed per head of Group II was the lowest in the first week of the experimental period and gradually increased. It reached 1480 gms in the last week. The average daily gain ranged between 101.5 $\pm$ 0.79 gms and 468.6 $\pm$ 1.15 gms. The minimum growth measure occurred in the first week, 1.88 gms s.v., the highest was 7.74 gms s.v.

The data of Group III found in Table 3 show that the average daily starch value consumed per head started by 880 gms in the first week and ended by 1110 gms in the last week of the experimental period. The average daily gain ranged between 86.4 $\pm$ 2.28 gms and 472.9 $\pm$ 1.28 gms.

The lowest growth measure in the four groups during the experimental period was recorded in the first week of Group III (1.86 gms s.v.).

It is clear from Table 4 that the average daily starch value consumed per head started by 820 gms and the highest was 1470 gms. The average daily gain ranged between 150.5 $\pm$ 0.90 gms and 586.7 $\pm$ 1.32 gms. Growth measure started in the first week by 2.06 gms s.v. and in the last week was 3.44 gms s.v.

The results of the experiment summarized in Table 5 indicate that the average daily starch value consumed per head of Group I and Group IV was

an individual pig during the experimental period; Group I

5	6	7	8	9	10	11
1040	960	1030	1540	1310	1360	1300
217.2 $\pm$ 1.33	367.2 $\pm$ 1.34	220.0 $\pm$ 1.31	360.0 $\pm$ 1.57	422.9 $\pm$ 1.89	291.5 $\pm$ 1.67	318.6 $\pm$ 0.63
4.79	2.61	4.68	4.28	3.10	4.67	4.08

Table 2

Daily requirement, daily gain and growth measure of

Periods in weeks	1	2	3	4
Average daily starch value gms	750	750	750	890
Average daily gain gms	399.3±0.99	101.5±0.79	275.8±1.40	404.3±0.72
Growth measure gms s.v.	1.88	7.39	2.72	2.20

Table 3

Daily requirement, daily gain and growth measure of

Periods in weeks	1	2	3	4
Average daily starch value gms	880	880	880	940
Average daily gain gms	472.9±1.28	86.4±2.28	396.5±1.00	255.0±1.18
Growth measure gms s.v.	1.86	10.19	2.22	3.69

Table 4

Daily requirement, daily gain and growth measure of

Periods in weeks	1	2	3	
Average daily starch value gms	820	820	820	910
Average daily gain gms	398.9±1.31	150.5±0.90	369.6±1.50	318.2±1.56
Growth measure gms s.v.	2.06	5.45	2.22	2.86

the same (1100 gms), higher than those of Group II (1080 gms) and Group III (1090 gms).

The average daily gain of Group I was the lowest (302.4 ± 1.29 gm), the highest was that of Group IV (335.3 ± 1.37 gm). The average daily gain of Group III (326.2 ± 1.39 gm) was higher than that of Group II (321.7 ± 1.14 gm).

The growth measure of Group IV was the lowest (3.71 gms s.v.), the highest was that of Group III (4.02 gms s.v.).

an individual pig during the experimental period; Group II

5	6	7	8	9	10	11
950	1040	1130	1360	1380	1380	1480
255.0±1.49	134.3±0.79	340.0±1.16	441.5±1.41	468.6±1.15	450.0±1.57	268.6±1.09
3.73	7.74	3.32	3.08	2.94	3.06	5.51

an individual pig during the experimental period; Group III

5	6	7	8	9	10	11
830	1360	1130	1400	1400	1210	1110
432.1±1.67	305.8±1.45	354.3±1.61	382.9±1.15	227.2±1.73	332.9±1.20	341.9±0.72
1.92	4.45	3.19	3.66	6.14	3.63	3.24

an individual pig during the experimental period; Group IV

5	6	7	8	9	10	11
750	1350	1130	1470	1300	1400	1340
385.3±1.50	322.3±1.66	296.7±1.09	586.7±1.32	156.9±1.09	313.4±1.59	389.5±1.56
1.95	4.19	3.81	2.51	8.29	4.47	3.44

The growth measure of Group I (3.88 gms s.v.) was lower than that of Group II (3.96 gms s.v.).

It was obvious from the statistical analysis of Student's „t" test of the daily gain between the control and Group II, III and IV that highly significant differences were found ($P < 0.01$). The difference between Group II and Group III was significant ($P < 0.05$), and the difference between Group II and Group IV was highly significant ($P < 0.01$). Significant difference occurred between Group III and Group IV ($P < 0.01$).

Table 6 shows that the variance due to the treatments was highly signifcant ($P < 0.05$).

Table 5

Daily requirement, daily gain and growth measure among different groups of pigs during the experimental period

Groups.	I	II	III	IV
Average daily starch value gms	1100	1080	1090	1100
Average daily gain gms	302.4 ± 1.29	321.7 ± 1.14	326.2 ± 1.39	335.3 ± 1.37
Growth measure gms. s.v	3.88	3.96	4.02	3.71

Table 6

Analysis of variance in daily gain of mixed sexes of Hungarian White pigs at different periods of growth studied

	Degrees of freedom (D.F.)	Some square (S.S.)	Mean square (Variance)	F. calculated	F. tabulated
Periods	10	1277.4	127.7	1.23	2.16
Treatments	3	1260.3	420.1	4.06	2.92
Residual	30	3107.8	103.6		
Total	43	5645.5			

Discussion

From the present study it can be concluded that the supplementation of manganese to the deficient diets for growing pigs during the experimental period increased the daily gain. The higher the level of manganese in the ration, the bigger the improvement in growth. The addition of manganese to the ration increased the daily gain of pigs in Group II, III and IV by 7.0, 8.0 and 12.0 per cent respectively higher than the control (Group I). Such results indicate that the average daily gain increased progressively with the level of manganese in the ration.

In this connection, LOUDIL—KALOUS (1960) reported that 0.3 mg manganese per kg live weight daily increased the daily gain of the piglets by 25 per cent higher than those that manganese was not given.

HAWKINS *et al.* (1955) found the growth rate of young dairy cattle fed on basal diet with supplemented manganese at a rate of 50 ppm to be significantly greater than calves fed basal diet without supplement.

The results show furthermore that although the average daily feed consumption was the same in Group I (control) and Group IV, yet the efficiency of feed utilization improved. The improvement in the feed conversion at 160 ppm manganese was 5.0 per cent.

Therefore, good evidence was obtained for the beneficial effect on the growth and feed utilization of Hungarian White pigs by the addition of manganese especially at a higher level. These results are in agreement with that reported by the National Research Council N.R.C. (1960).

ROBINSON *et al.* (1960) studied the effect of excess dietary manganese on the performance of beef cattle and they found that manganese added to the ration improved the feed efficiency and growth.

They concluded the effects of excess manganese to be greater on the function than on the structure in tissues and other organs.

In contrast LEHRER—KEITH (1960) found that the growth rate, feed consumption and efficiency of feed utilization were not improved by manganese addition to the diet of growing swine.

CUNNINGHAM *et al.* (1966) showed that the minimum toxic level of manganese for growing calves was between 820 and 2460 ppm. They reported that no significant differences were found in feed efficiency at different levels of manganese.

Several workers in the field of animal nutrition reported a beneficial response from copper when used as feed additive for swine ration.

The data obtained from the present study showed that the average daily gain of animals that had received 100 ppm copper (Group I and Group II) was 312.1 $\pm$ 1.22 gm, less than the average daily gain of pigs receiving 200 ppm (Group III and IV) which was 330.8 $\pm$ 1.38 gm. The increase in average daily gain was about 6 per cent. Such results indicate that the addition of copper to the deficient diet at the higher level (200 ppm) improved the growth of pigs during the experimental period. LUCAS *et al.*, when studying (1961) the effect of copper on the growth of pigs, they found that pigs receiving 125 or 250 ppm copper grew 4 or 9 per cent faster and had better efficiencies of feed conversion than those having less copper supplementation. SCHURCH (1956) added 230 ppm of copper (slightly higher than the high level used in this experiment) to the ration of pigs and noted an increase in gain of body weight and an improvement in feed utilization. He suggested that the copper may have protected the pigs against an infection that affected the control.

In 1955 BARBER *et al.* (1955) observed that the daily gains of growing pigs were significantly improved by feeding 250 ppm of supplementary copper.

Most of the workers have recommended 250 ppm copper. This quantity added to usual swine rations has increased gains significantly. BOWLER *et al.* (1955), ALLEN *et al.* (1958), SCOTT (1958), BARBER *et al.* (1960), BUNCH *et al.*

(1960), MILOSAVLJEVIC *et al.* (1960), ALLEN *et al.* (1961), BARBER *et al.* (1961), BUNCH *et al.* (1961), RUSZCZYC—GLAPS (1962) — BUNCH *et al.* (1963).

It is evident from this work also that there were no significant differences between the values of growth measure. The average growth measure of the animals having received 100 ppm copper was 3.92 being slightly higher than that of pigs having received 200 ppm copper which was 3.87. This finding indicates that the efficiency of feed utilization is slightly improved when the

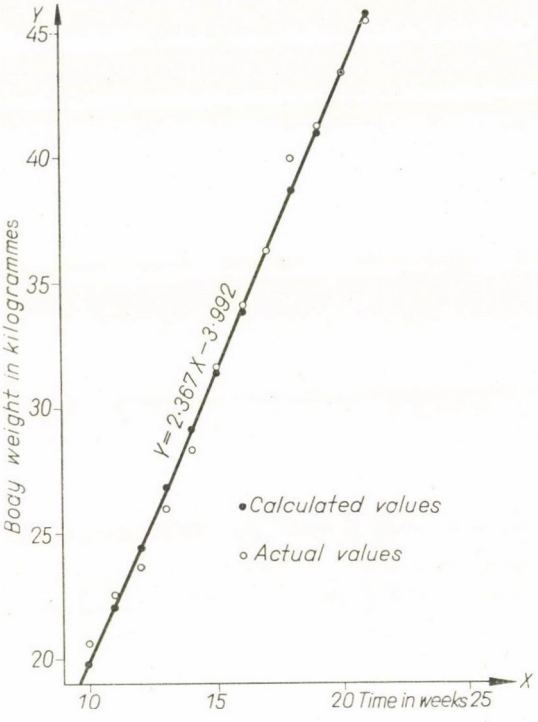

Fig. 1. Regression of weight on the age of male pigs (Group IV)

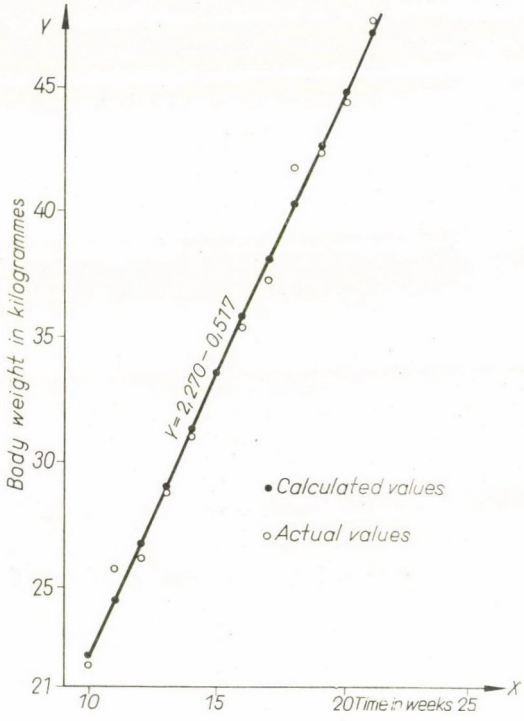

Fig. 2. Regression of weight on the age of female pigs (Group IV)

higher level of copper is added to the diet. Such result is in agreement with that reported by FAGAN *et al.* (1961).

Although there was a slight improvement in the feed conversion when a higher level of copper was added to the pig diet, yet the average daily starch value consumed was higher. This finding is in accordance with that obtained by HENNIG (1961).

In contrast, WALLACE *et al.* (1961) reported no marked or consistent improvement of growth or feed efficiency on any level of copper supplementation up to 200 ppm, and from 250 to 750 ppm there were toxicity levels.

The relation between the age and the weight of Group IV (having received 160 ppm manganese and 200 ppm copper) was found to be significantly linear. The following regressions of weight on the age for male (Fig. 1) and female pigs (Fig. 2) were obtained:

$$\text{Male pigs} \qquad Y = 2.367\,X - 3.992$$
$$\text{Female pigs} \qquad Y = 2.270\,X - 0.517$$

where Y is the calculated weight in kg at X-week age.

REFERENCES

ALLEN, M. M.—BARBER, R. S.—BRAUDE, R.—MITCHELL, K. G. (1958): Copper and zinc supplements for fattening pigs. Proc. Nutr. Soc. British, **17,** XII.

ALLEN, M. M.—BARBER, R. S.—BRAUDE, R.—MITCHELL, K. G. (1961): Further studies on various aspects of the use of high-copper supplements for growing pigs. Brit. J. Nutr., **15,** 507—522.

BARBER, R. S.—BRAUDE, R.—MITCHELL, K. G.—CASSIDY, J. (1955): High copper mineral mixture for fattening pigs. Chem. and Indust., **21,** 601.

BARBER, R. S.—BRAUDE, R.—MITCHELL, K. G.—ROOK, R. D. F.—ROWELL, J. G. (1957): Further studies on antibiotic and copper supplements for fattening pigs. Brit. J. Nutr., **11,** 70.

BARBER, R. S.—BOWLAND, J. P.—BRAUDE, R.—MITCHELL, K. G.—PORTER, J. W. (1961): Copper sulfate and copper sulfide (CuS) as supplements for growing pigs. Brit. J. Nutr., **15,** 189.

BECKER, J. E.—MCCOLLUM, E. V. (1938): Toxicity of $MnCl_2 \cdot 4\,H_2O$, when fed to rats. Proc. Soc. Exp. Biol. Med., **38,** 740.

BEESON, K. C.—GENNARD, M. (1950): The nutrient element content of native forage in relation to land forms and soil types in the north coastal plain. Copper Metabolism, a Symposium on Animal Plant and Soil Relationships.

BELLIS, D. B. (1961): Supplementation of bacon pig rations by aureomycin and two levels of copper sulphate. Animal Prod., **3,** 89—95.

BLAKEMORE, F.—NICKLESON, J. A.—STEWART, J. (1937): Some effects of high manganese content in the diet of animals, with special reference to lactation tetany. Vet. Record., **49,** 415—422.

BOWLER, R. J.—BRAUDE, R.—CAMPBELL, R. C.—CRADOCK-TURNBULL, J. N.—FIELDSEND, H. E.—GRIFFITHS, E. K.—LUCAS, I. A. M.—MITCHELL, K. G.—NICKALLS, N. J. D.—TAYLOR, J. H. (1955): High copper mineral mixture for fattening pigs. Brit. J. Nutr., **9,** 358.

BUNCH, R. J.—SPEER, V. C.—HAYS, V. W.—HAWBAKER, J. A.—CARTON, D. V. (1961): Effect of copper sulfate, copper oxide and chlortetracycline on baby pigs performance. J. Animal Sci., **20,** 723.

BUNCH, R. J.—SPEER, V. C.—HAYS, V. W.—MCCALL, J. T. (1963): Effect of high levels of copper and chlortetracycline on performance of pigs. J. Animal Aci., **22,** 56.

CHORNOCK, C.—GUERRANT, N. B.—DUTCHER, R. A. (1942): Effect of manganese on calcification in the growing rat. J. Nutr., **23,** 443.

CUNNINGHAM, G. N.—WISE, M. V.—BARRICK, E. R. (1966): Effect of high dietary levels of manganese on the performance and blood constituents of calves. J. Animal Sci., **25,** 532—538.

EID, T. (1953): Agricultural experiments and statistics. 1st edit. Maktabet El-Nahda El-Misriah Cairo. (In Arabic)

EVVARD, J. M.—NELSON, V. E.—SEWELL, W. E. (1928): Copper salts in nutrition. Iowa Acad. Sci., **35,** 211.

FAGAN, V. J.—ILES, R. D.—SLOWITSKY, Z.—BROCKSOPP, R. E. (1961): Some observations on the high level copper supplementation of pig rations. J. Agric. Sci., **56,** 161—164.

GENNARD, M.—HARTMAN, R. H.—CLAWSON, A. J. (1959): Studies of a manganese-iron antagonism in the nutrition of rabbits and baby pigs. J. Nutrition, **67,** 309.

GRUMMER, R. H.—BENTLEY, O. G.—PHILLIPS, P. H.—BOHSTADT, G. (1950): The role of manganese in growth, reproduction and lactation of swine. J. Animal Sci., **9,** 170.

HANSARD, S. L.—HASKINGS, F. H.—NEELER, B. O.—BARTH, J. (1960): Effect of excess dietary manganese on iron metabolism in the rat. J. Animal Sci., **19,** 635.

HAWBAKER, J. A.—SPEER, V. C.—HAYS, W. W.—CARTON, D. V. (1961): Effect of copper sulfate and other chemotherapeutics in growing swine rations. J. Animal Sci., **20,** 163.

HAWKINS, G. E.—WISE, G. H.—MARTONE, G.—WAUGH, R. K.—LOTT, W. L. (1955): Manganese in the nutrition of young dairy cattle fed different levels of calcium and phosphorous. J. Dairy, Sci., **38,** 536—547.

HELLER, V. G.—PENQUITE, R. (1937): Factors producing perosis in chicks. Poult. Sci., **16,** 243.

HENNING, A. (1961): Addition of copper sulphate to the fattening ration of pigs. Jahrb. Arbeitsgemeinschaft und Fütterungsberatung, **3,** 155—162.

LEHRER, W. P. (Ir.)—KEITH, T. B. (1960): Zinc, manganese and pyridoxine supplementation of high calcium and phosphorous rations for growing swine. Univ. Idaho Agric. Exp. Stat. Res. Bull., **48,** 12.

LEIBHOLZ, J. M.—SPEER, V. C.—HAYS, V. W. (1962): Effect of dietary manganese on baby pig performance and tissue manganese levels. J. Animal Sci., **21,** 772.

LOUDIL, L.—KALOUS, J. (1960): Effect of the trace elements of cobalt and manganese on growth and development of piglets. Zivocisna Vyroba, **5,** 663—670.

LUCAS, I. A. M.—LIVINGSTONE, R. M.—MCDONALD, I. (1961): Copper sulphate as a growth stimulant for pigs. Animal Prod., **3,** 111—119.

MILOSAVLJEVIC, S.—SOVLJANSKI, B.—PEJIN, R. (1960): Influence of copper sulfate in the feed on growth and feed utilization in pigs. Vet. Glasnik, **14,** 841—847.

MOINUDDIN, J. F.—LEE, H. W. (1960): A limitary blood and other changes due to feeding $MnSO_4$ and Na_2SO_4. Am. J. Physiol., **199,** 77.

National Research Council (1960): Nutrient requirements of domestic animals. Nutrient requirements for animals.

ROBINSON, N. W.—SAM, L.—HANZARD, J. D. M.—ROBERTSON, G. L. (1960): Excess dietary manganese and feed lot performance of beef cattle. J. Animal Sci., **19,** 1290.

RUSSEL, F. C. (1944): Minerals in pasture deficiencies and excesses in relation to animal health. Imperial Bureau of Animal Nutrition. Tech. Comm., **15,** 69—85.

RUSZCZYC, Z.—GLAPS, J. (1962): Copper sulphate and oxytetracycline for fattening pigs. Rocz. Nauk., (B) **78,** 569—575.

SCHURCH, A. (1956): The effect of high copper doses upon the weight gain of pigs. Mitt. Gebiete Lebensm. u. Hyg., **47,** 458.

SCOTT, K. V. (1958): Recent nutritional research at the University of Arkansas. The proceedings of the swine study day July 3.

SNEDECOR, G. W. (1956): Statistical methods. (1st Edit.) The Iowa State College Press. Ames, Iowa.

STUART, M.—HARBAUGH, F. G.—DENNIS, J. (1950): A quantitative investigation of some mineral components of wheat plants. Am. J. Vet. Res., **11,** 400—401.

WALLACE, H. D.—MCCALL, BILLY J. T.—COMBS, G. E. (1960): High level copper for growing swine. J. Animal Sci., **19,** 1153

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THE EFFECT OF KINETIN ON THE ACCUMULATION OF PIPECOLIC ACID IN ISOLATED LEAVES

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A correlation among bean, tobacco and sunflower leaves was investigated as regards total protein, total amino acid concentration and pipecolic acid content. For this purpose, the leaves were isolated. One half was placed in tap water, the other in kinetin solution for 6 days. The leaves remaining on the shoot were used as control. Our experimental data showed that the quantity of total soluble protein decreased due to the effect of isolation, total amino acid concentrations especially the aspargin and glutamin content increased, while at the same time pipecolic acid appeared among the amino acids. The protein content did not decline in isolated but kinetin treated leaves, in fact it surpassed the value of the quantity of soluble proteins of the control leaves. The amino acid content decreased, and the pipecolic acid in this variant leaves could not be shown in the same way as in the control. On the basis of our results, it could be established that the appearance of pipecolic acid in the organs above ground indicating intensive protein decomposition serves to demonstrate that the hormonal regulating role of the roots, the synthesis of kinetin-like materials is somehow inhibited.

Introduction

The role of pipecolic acid, a non-protein-producing amino acid, in the amino acid metabolism of plants is hardly known. COULSON (1955) could isolate pipecolic acid from a very large number of leaves only. PETINOV (1961) classified it under the rarely occurring amino acids. According to BERNFELD (1963) pipecolic acid belongs to the basic materials of certain alkaloids. According to STEWARD (1965) pipecolic acid has come from lysin and it transforms to aminoadipic acid and then by means of decarboxylation, to glutamic acid. YATSU—BOYNTON (1959), using strawberry leaves sprayed with a growth inhibiting substance, obtained a significant quantity of pipecolic acid. SEGHAL—BOONE (1964) found pipecolic acid in leaves of strawberries inoculated with a virus and FAM—PLESKOV (1963) in bean leaves grown in absence of phosphorus. In our previous investigations, pipecolic acid was demonstrated to be present in rice leaves grown in unfavourable conditions or inoculated with *Piricularia* (PÁLFI 1965). Later on soya beans, potatoes, tobacco, wheat and sunflowers were inoculated with fungi, bacteria or virus. It could be demonstrated that pipecolic acid was present in the leaves in the initial phase of inoculation (PÁLFI 1967). At the same time, pipecolic acid either was not formed or was formed only in negligible quantity in the leaves of rice types more resistant against *Piricularia* (PÁLFI 1968). Pipecolic acid appears in the leaves

even in case of lasting water deficiency and with the decrease of the protein content in pea, bean, sunflower and tobacco plants (PÁLFI 1968a, 1968b).

Lately it has been observed that the ratio of protein synthesis and decomposition is in favour of the latter, not only at the time of inoculation but also during the elimination of the roots, and the isolation of the leaves (FARKAS 1963). This process is combined with the accumulation of amino acids and the change of enzyme activities.

However, when the isolated leaves are treated with kinetin, the protein synthesis can be restored to the normal level (KULAEVA—VOROBYEVA 1962, SUGIURA *et al.* 1962, WOLLGIEHN 1961 and many others). It has been shown by isotopic methods that kinetin enhances the incorporation of the mentioned amino acids into the proteins (OSBORNE 1962, PARTHIER 1961).

Furthermore the question arises what connection exists between the intensity of protein synthesis and the formation of pipecolic acid in the leaves of healthy plants as well as of plants with abnormal metabolism. In our present experiment, therefore, the effect of isolation and kinetin treatment on total soluble proteins, amino acids and pipecolic acid contents of leaves were examined.

Material and Method

Bean (Black prince), tobacco (from Szabolcs) and sunflower (from Kisvárda) plants were grown in pots (5 kg) filled with sand and soil (2 : 1). Artificial illumination was of 14 hrs duration every day (4000 lux), the temperature being 18—22 °C. Occasionally they were irrigated with the knop solution. When the primary leaves developed, one of those was cut, the others remained on the shoot as control. The isolated leaves were cut along the main vein, one half was floated in tap water in a Petri dish, the other in 10^{-5} M kinetin solution for 6 days, with 14 hrs illumination. The control leaves which remained on the shoot were cut off and washed in distilled water and were blotted along with the treated ones. Their fresh weight was taken, one part was used for determining proteins, the rest was fixed at 65 °C and dried out. The pipecolic acid was identified by adding standard solutions of known concentration drop by drop (see YATSU—BOYNTON 1959). The GLU-NH_2 and ASP-NH_2 determinations were done according to the KRETOVICH—KASPAREK (1961) method.

The amino acid analyses were carried out with powdered dry matter. The 50 per cent ethanol extracts were developed on one and two dimension paper chromatography (Sch-Sch 2041b) and on thin layer chromatography (cellulose-silica gel 3 : 1). The solvent was butanol—acetic acid—water (2 : 1 : 1) and phenol—ethanol—water (3 : 1 : 1). Ninhydrin and isatin were used for the development. The soluble total protein was established according to LOWRY *et al.* (1951).

Results and Discussion

The total soluble protein and pipecolic acid contents are reported in Table 1. It can be seen that the protein quantity in isolated leaves and in that kept in tap water was the minimum. In leaves treated with kinetin, it not only reached the control value but quite significantly surpassed it. At the same time pipecolic acid could be shown as variant only in the isolated tap water, which coincided with the decreased protein content. It could be established, therefore, that if the decrease of the protein content due to isolation is inhibited

Table 1

The effect of isolation and 10^{-5} M kinetin treatment on the soluble total protein and pipecolic acid contents of bean, tobacco and sunflower leaves

Plants	Treatment	Soluble total protein mg/fresh material	Pipecolic acid mg/g dry material
Bean	Control	11.03 ± 0.52	—
Phaseolus vulgaris L.	Isolated in tap water	10.08 ± 0.48	0.74 ± 0.032
	Isolated in kinetin solution	16.43 ± 0.66	—
Tobacco	Control	11.56 ± 0.54	—
Nicotiana tabacum L.	Isolated in tap water	10.88 ± 0.46	0.58 ± 0.03
	Isolated in kinetin solution	14.83 ± 0.68	—
Sunflower	Control	7.77 ± 0.32	—
Helianthus annuus L.	Isolated in tap water	6.85 ± 0.30	0.32 ± 0.016
	Isolated in kinetin solution	9.40 ± 0.44	—

Table 2

The effect of isolation and 10^{-5} M kinetin treatment on the dry matter, Glu-NH_2 + Asp-NH_2 and total amino acid contents of bean, tobacco and sunflower leaves

Plants	Treatment	Dry material/10 g fresh weight	Glu-NH_2 + Asp-NH_2 mg/g	Total amino acid dry matter
Bean	Control	1.00	0.85 ± 0.04	11.86 ± 0.56
	Isolated in tap water	1.21	2.46 ± 0.114	17.24 ± 0.82
	Isolated in kinetin solution	1.32	1.06 ± 0.05	13.12 ± 0.60
Tobacco	Control	1.12	1.12 ± 0.06	12.58 ± 0.58
Nicotiana tabacum L.	Isolated in tap water	1.36	2.38 ± 0.12	18.66 ± 0.88
	Isolated in kinetin solution	1.45	1.08 ± 0.05	12.85 ± 0.62
Sunflower	Control	0.88	0.72 ± 0.32	7.73 ± 0.34
Helianthus annuus L.	Isolated in tap water	1.15	1.76 ± 0.08	12.16 ± 0.56
	Isolated in kinetin solution	1.28	0.82 ± 0.04	8.28 ± 0.38

by kinetin treatment, then the pipecolic acid indicating leaf tissue decay cannot be shown to be present.

In Table 2 the total amino acid and amide contents are reported. These data agreed to what has been said before, according to which the protein

decomposition due to isolation is combined with the increase of amino acids. As an effect of kinetin treatment the amino acids content decreased parallel with the increased protein decomposition. A similar coincidence was found in the amide content too, as demonstrated by our investigations and that of others, that the amide content increases when the protein quantity decreases.

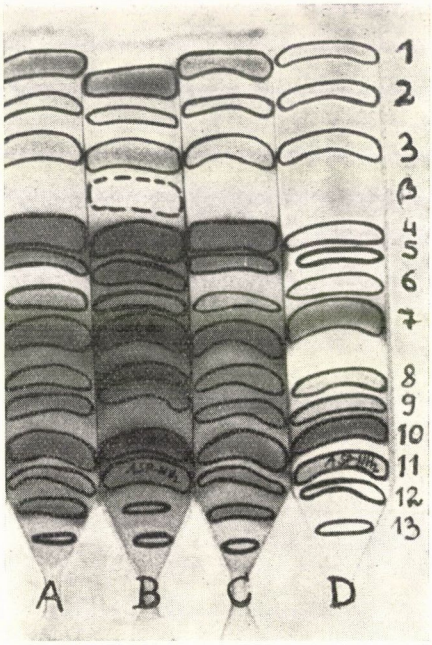

Fig. 1. Free amino acids of isolated bean leaves kept in tap water for 6 days or in kinetin solution as well as of non-isolated ones. "A" = non-isolated; "B" = isolated in tap water; "C" = isolated in kinetin solution; "D" = comparable amino acid mixture; 1 = Leu + Ileu; 2 = Phe; 3 = Val + Met; 4 = γ — AMB; 5 = Tyr; 6 = Pro; 7 = Ala; 8 = Glu + Thr; 9 = Gly + Ser; 10 = Glu-NH_2 + Asp; 11 = Asp-NH_2 + Arg; 12 = Lys; 13 = Cys; β = pipecolic acid

The presence of amino acids and amides was also shown by paper and layer chromatographic procedures. In Fig. 1 the paper chromatographic photo of bean leaf extract is given. It shows that the free amino acids and amide content are the biggest in the variant floated on water, which also points to the rise of protein decomposition. Pipecolic acid also appeared among the amino acids in this variant, which however indicates the weakened physiological state of the plant (PÁLFI—DÉZSI 1968).

From the two-dimensional chromatogram of Fig. 2 it can be seen also that the amino acid, alanine and glutamine of the variant kept in tap water for 6 days appeared in big spots but especially big was the asparagine spot and significantly so, the pipecolic acid spot. Since the investigations with similar

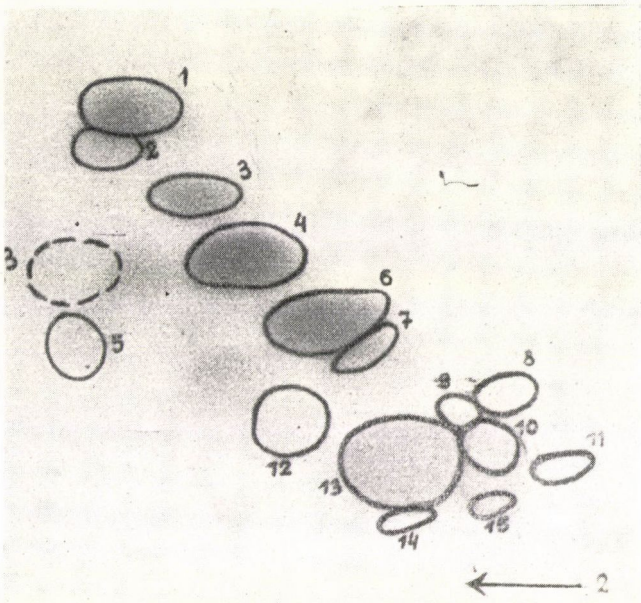

Fig. 2. Free amino acids of bean leaves isolated and kept in tap water for 6 days. Thin layer chromatogram. 1 = Leu + Ileu; 2 = Phe; 3 = Val + Met; 4 = γ —AMB; 5 = Pro; 6 = Ala; 7 = Thr; 8 = Glu; 9 = Gly; 10 = Ser; 11 = Asp; 12 = Glu-NH_2; 13 = Asp-NH_2; 14 = Lys; 15 = Cys; β = pipecolic acid

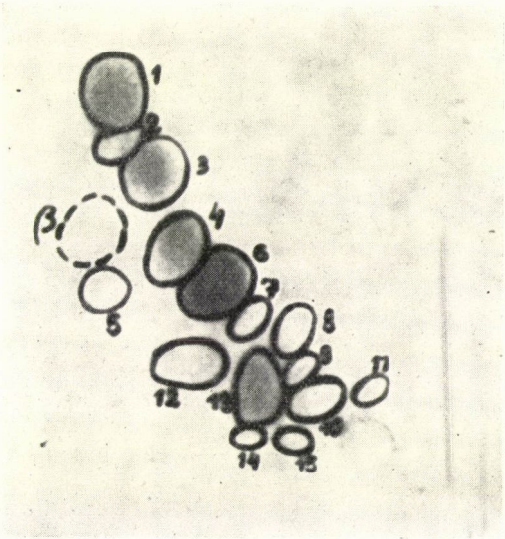

Fig. 3. Free amino acids of isolated tobacco leaves after dipping in tap water for 6 days. 1—15 = the same as on Fig. 2. β = pipecolic acid

treatments on tobacco and sunflower gave similar results, only the photos of leaf extract layer chromatographs covered with tracing paper are reported (Figs. 3 and 4). On both chromatograms quite large amide and pipecolic acid spots can be seen. As is known, the glutamine quantity changes more quickly between glutamine and asparagine. With the rise of protein decomposition, glutamine appears first. The asparagine can only be proved in case of a last-

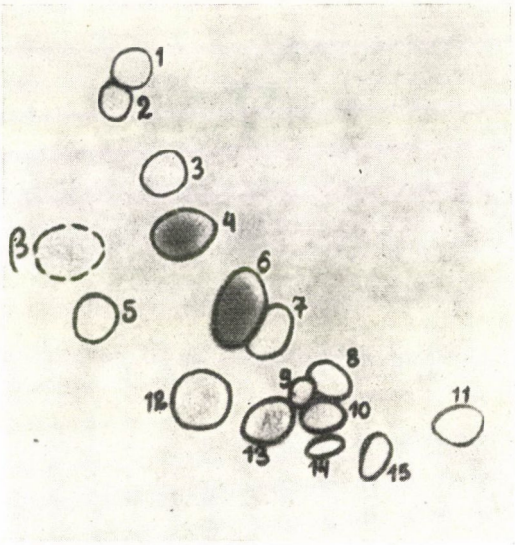

Fig. 4. Free amino acids of isolated sunflower leaves after dipping in water for 6 days. 1—15 = the same as in Fig. 2. β = pipecolic acid

ing superfluous NH_2 group. If, besides all these pipecolic acid occurs in free amino acids it may be that the ratio of protein synthesis and decomposition is in favour of the latter (PÁLFI 1967b).

Conclusions

Data obtained from investigations on leaves of bean, tobacco and sunflower uniformly showed that pipecolic acid really appears in significant quantity among the free amino acids of leaves if the soluble total protein content decreases. YATSU—BOYNTON (1959) came to the conclusion that this non-protein producing amino acid can accumulate in surprising quantities in the leaves of such plants in which protein synthesis and plant growth is inhibited. If, however, the protein content in isolated leaves grows due to the effect of kinetin treatment, pipecolic acid cannot be shown to be present in the same way as in plants with roots, not isolated and adequately nourished. This serves to show that the appearance of pipecolic acid in the leaves is not caused by

isolation, but by changed metabolism and intensive protein decomposition. These data agreed with those obtained in the investigations on rice plants infected with *Piricularia*, where it was likewise impossible to show pipecolic acid in the more resistant species. The kinetin, like phytohormones synthesizing in the roots (which are introduced into the isolated leaves from outside) are indispensable in the normal protein synthesis of leaves and above ground organs (KULAEVA 1962). If, therefore, the root system is damaged in some way this is obvious from not only a rise in protein decomposition in the leaves, but probably also from the accumulation of such destructive metabolistic products as pipecolic acid. It is not known at present how pipecolic acid affects and modifies the already changed metabolism products. According to our opinion, since the spatial structure of pipecolic acid, especially (COOH, NH_2) the group arrangement is quite similar to the prolin composition, it may inhibit the competitive incorporation of prolin into peptide. This question, however, needs further study.

REFERENCES

BERNFELD, P. (1963): Biogenesis of natural compounds. Pergamon Press. Oxford—London—New York—Paris.

COULSON, C. B.—BOONE, D. M. (1955): New free amino acids in plant materials. Nature, **176,** 518—519.

(FAM, S. K.—PLESKOV, B. P.) Фам, Ш. К.—Плешков, Б. П. (1963): Влияние уровня питания растений фосфором на содержание свободных аминокислот в листях и бобах фасоли. Докл. Моск. с—х. Акад. им. К. А. Тимирязева **94,** 292—293.

FARKAS, G. (1963): Endogén és exogén tényezők a növények protein anyagcseréjének szabályozásában (Endogenous and exogenous factors in the regulation of the protein metabolism). MTA Biol. Tud. Oszt. Közl., **6,** 269—284.

(KRETOVICH, V. L.—KASPAREK, M.) Кретович, В. Л.—Каспарек, М. (1961): Биосинтез аминокислот из пировиноградной кислоты и аммония у риса и подсолнечника.

(KULAEVA, O. N.) Кулаева, О. Н. (1962): Влияние корней на обмен веществ листьев в связи с проблемой действия на лист кинетина. Физ. Раст. **2,** 229—239.

(KULAEVA, O. N.—VOROBYEVA, M. P.) Кулаева, О. Н.—Воробьева, М. П. (1962): К вопросу о механизме действия кинетина на синтез белка. Физ. Раст. **9,** 106—108.

LOWRY, O. H.—ROSENBROUGH, N. J.—FARR, A. L.—RANDALL, R. J. (1951): Protein measurement with the folin-phenol reagent. J. Biol. Chem., **193,** 265—275.

OSBORNE, D. J. (1962): Effect of kinetin on protein and nucleic acid metabolism in *Xanthium* leaves during senescence. Plant. Phys., **37,** 595—602.

PARTHIER, B. (1961): Über den Einfluß des Kinetins auf die Aminosäure — Inkorporation in Blattscheiben von Tabak. Flora, **151,** 518—534.

PÁLFI, G. (1965): Relations between abundant N-supply and the amino acid concentration of various leaf levels of rice plants. Plant and Soil, **23,** 275—284.

PÁLFI, G. (1967a): Aminosäuren-Assimilation einiger Bakterien und ihre Verwendung zum Nachweis einer unbekannten Verbindung. Naturwissenschaften, **15/16,** 54.

PÁLFI, G. (1967b): A beteg rizs, szója, burgonya és dohány növények rendellenes aminosav anyagcseréjének új közös indikátora (New, common indicator of the irregular amino acid metabolism of diseased, rice, soybean and tobacco plants). Agrokémia és Talajtan, **16,** 645—652.

PÁLFI, G. (1968a): Changes in the amino acid content of detached wilting leaves of *Solanum laciniatum* Ait. in the light and in the dark. Acta Agronomica Acad. Sci. Hung., **17,** 381—388.

PÁLFI, G. (1968b): Die Wirkung von Kinetin, 2,4-DPN und Antimetaboliten auf die Veränderungen im Aminosäurengehalt welkender Pflanzenblätter. Planta, **78,** 196—199

PÁLFI, G. (1968c): Relationship between the pipecolic acid content of the leaves and the physiological condition of rice plant. Il Riso, **17,** 13—22.

PÁLFI, G.—DÉZSI, L. (1968): Pipecolic acid as an indicator of abnormal protein metabolism in diseased plants. Plant and Soil, **19,** 285—291.

PETINOV, B. P. Петинов, Б. П. (1961): Аминокислоты растений. Известия Тимирязевской сельскохозяйственной Академии. **43,** 17—31.

SEHGAL, O. P.—BOONE, D. M. (1964): Amino acid and amide content of healthy and multiplier disease — affected strawberry plants. Phytopathology, **54,** 775—778.

STEWARD, F. C. (1965): Plant Physiology. Academic Press. New York and London

SUGIURA, M.—UMEMURA, K.—OATA, Y. (1962): The effect of kinetin on protein level of tobacco leaf disks. Physiol. Plant., **15,** 457—464.

WOLLGIEHN, R. (1961): Untersuchungen über den Einfluß des Kinetins auf den Nukleinsäure- und Protein-Stoffwechsel isolierter Blätter. Flora, **151,** 411—437.

YATSU, L.—BOYNTON, D. (1959): Pipecolic acid in leaves of strawberry plants as influenced by treatments affecting growth. Science, **130** 864—865.

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POLLEN TUBE GROWTH OF EGGPLANT (SOLANUM MELONGENA L.) IN VIVO AND IN VITRO

By

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If at various dates after artificial pollination a part of the style is cut off, from the number of seeds produced in fruits the speed of fertile particles of pollen tubes can be concluded on. By means of in vitro pollen germination the linear growth velocity of pollen tubes, the length of protoplasm containing tubes of empty pollens, while by staining with carmine acetic acid the location of fertile particles in the pollen tube can be determined. With these data obtained the linear growth velocity of pollen tubes can be determined in vivo. When comparing the linear growth velocity values of pollen tubes obtained in vivo and in vitro, it is found that the growth velocity of pollen tubes in vivo is nearly three times as high as in vitro.

Introduction

In vitro germination on various media and stainability of pollen tubes were studied by many (CONN—DARROW—EMMEL 1960, DANIEL 1952), because the growth capacity of tubes was considered the criterion of pollen viability. In the course of investigations it was found that in addition to the composition and pH-value of media the extent of pollen tube growth was influenced by the relative humidity of air (MORTENSON—PELOQUIN—HOUGAS 1964), darkness and light, temperature (LEHMAN—PURI 1964), extracts and secreta of own and alien pollens (MORTENSON—PELOQUIN—HOUGAS 1964, GOLUBINSKY 1966, LJU DA-CZUN 1959), extract made of the flowers (HRISTOV—GENCHEV 1964) and parts excised from the flowers (LINCK 1961). The growth velocity of pollen tubes is not, however, uniform even under homogeneous conditions, it is highest in the first hours (LVOVA 1958) which is partly proved by results obtained when examining S^{35} and P^{32} labelled pollens getting into the ovary (DIMITRIEVA 1958, ZDRILKO—HAVZHINSKAYA 1958). Besides those known so far, an increasing number of new compounds have been recently discovered either stimulating or inhibiting the growth of the pollen tube (SIMOLA 1967, BRITIKOV—MUSATOVA—VLADIMIRCEVA 1966). Namely, the optimum in vitro condition of tube growth similar to that existing in the tissue of the style has not been found so far, that is, nutrient composition corresponding best to the in vivo conditions is not yet known. In addition, there are difficulties in creating a homogeneous environment, as even in the thermostat, in its different parts the conditions of tube growth are significantly different (WEILING 1962).

Thus data on tube growth and tube length (LEHMAN—PURI 1964, LVOVA 1958, KENDALL 1967, SMAGINA 1958, PFAHLER 1965, 1967) refer only to the given in vitro conditions and probably are not identical with the velocity of tube growth in the tissues of the style.

In vivo the velocity of pollen tube growth depends on the growing method of plants — field, greenhouse — (MILLER—SCHONHORST 1968) and in the tassel on the level of earlets (PALAMARCHUK 1966). The velocity of pollen tube growth is influenced, furthermore, by the viability of pollen and style (WALDEN—EVERETT 1961), the age of the mother plant (RÖBBELEN 1960), the self-incompatibility in case of cross-breeding plants (LINSKENS 1961, TUPY 1959) and by the attraction of synergides (DIBOLL—LARSON 1966). It has been pointed out, namely, that a physiological relation, an interaction is produced between the pollen tube and the tissues of the style (LINSKENS—ESSER 1959, MIKI-HIROSIGE 1964, WELK—MILLINGTON—ROSEN 1965).

When comparing the velocity of pollen tube growth in vitro to that in vivo it is found that in the tissues of the style pollen tube growth is different from that on culture media (MIHAYLOVA 1959). Pollens of certain *Nicotiana* hybrids are not able to grow normal tubes on styles of either other hybrids ort he parents, at the same time in vitro grow tubes in 90 per cent (KRISHNAMURTY—APPARAO 1958). In in vitro experiments chemotropism induced by the styles is also independent of the in vivo compatibility of combinations (ROSEN 1961). Velocity of pollen tube growth — apart from self-incompatibility — is lower in vivo than in vitro due to the effect of inhibiting substances (MCWILLIAM 1960). Thus, it is undecided, that in the same plant species what difference can be found between in vitro and in vivo velocity of pollen tube growth. It must be noticed here that tube growth values refer only to the growth capacity of pollens in either culture media or style tissues and do not show their fertilization capacity (WALDEN—EVERETT 1961, DEMPSEY 1962).

Material and Method

In vitro conditions. Pollen germination under artificial conditions renders it possible to determine the linear growth velocity of pollen tube. The linear growth velocity of pollen tube can be determined by dividing the distance between the pore of the pollen and the tip of the tube with the time required for the tube to make this distance.

Pollens of yellow ripe anthers of *S. melongena* L. were germinated on culture medium. The culture medium was made of the mixture of 5 cm^3 sugar solution and 5 cm^3 Á-Z solution. In the composition of the culture medium the concentration of the sugar solution was changed (sugar solutions of 1, 2, . . ., 9, 10 per cent) while its quantity remained unchanged, i.e. 5 cm^3. Highest percentage pollen germination and longest tubes developed in unit time were found with the 5 per cent sugar concentration. So pollen tube germination was performed on a culture medium prepared of 5 cm^3 10 per cent sugar solution +5 cm^3 Á-Z solution. The culture medium was smeared on slides, 1 drop per each, and pollens of ripe yellow anthers were spread evenly and not too thickly on the slides. Petri-dishes had been padded with cotton-wool soaked in hot water before the slides were placed in them, in order to create an atmosphere saturated with humidity for the pollen germination. Petri-dishes thus prepared were placed in a thermostat of 30 °C temperature and kept in darkness for the required period.

All Petri-dishes were placed in the thermostat at the same time and every hour 3 of them were taken out. Each Petri-dish contained 2 slides, the length of 20 pollen tubes per slide was measured. Data were statistically processed and evaluated.

In vivo conditions. Growth velocity of pollen tubes cannot be determined in vivo by methods known so far. If at different dates after artificial pollination a part of the style is cut off, from the number of seeds produced in fruits the speed of the fertile particle (generative cells) of the pollen tube can be concluded on. Namely, if the fertile particle of the pollen developing a tube on the style has covered a distance longer than the part of style to be cut off, then fruits will contain seeds, viz. in the proportion of particles that have already made that distance. On the other hand, if the fertile particle has not covered that distance in the style but is still in the part of style to be cut off, then fertilization does not take place and fruits will not contain seeds.

Flowers of eggplant varieties were castrated when buds, when corollae began to grow out of calyces. At that time microsporogenesis is at an initial phase, diads just begin to develop from the microspore mother cells, so anthers are still closed. No self-pollination and self-fertilization can take place in flowers at that stage of development. Castrated flowers were isolated, and after three or four days, when corollae grown out of calyces had got already colour and petals were open, that is, styles became fertilizable, pollens of three anthers were placed on each style at a given time. 1/2, 1, $1^1/_2$ . . . 8, $8^1/_2$, 9 hours later pieces of 2.5 mm (2500 micron) were cut off the styles. So a total of 20 combinations were obtained; examinations were carried out in 1967 and 1968 with 20 flowers per combination. A combination in which flowers were only castrated and isolated served for the purpose of controlling castration.

During and after the artificial pollination, further, before and after cutting off a part of the style, flowers were constantly isolated, so they could be fertilized only by pollens placed on the styles at a given time.

Staining with carmine acetic acid. With pollens developing tubes the length of the protoplasm containing tube — that is the distance between the tip of the tube and the diaphragms separating the protoplasm from the empty pollen at right angles to the length of the tube — can be determined. By staining with carmine acetic acid the location of fertile particles in the tubes can also be determined.

Carmine acetate was dropped on pollens developing tubes on culture medium smeared on a slide; then latter was repeatedly passed over the flame of a spirit-lamp.

In the course of our experiments the following problems were studied: 1. in vitro a) what is the linear growth velocity of pollen tubes, b) what is the length of the protoplasm containing part of the empty pollen, c) where are the fertile particles located in the tube containing protoplasm; 2. in vivo what is the speed of the fertile particle of pollen tube; the ultimate object was to determine the in vivo growth velocity of pollen tubes.

Results

In vitro conditions. It is linear growth velocity of pollen tubes that can be determined in vitro. The linear growth velocity of pollen tube is the result of distance between pollen pore and tube tip divided by the time spent.

Results of investigations made in this direction are presented in Table 1. Data of Table 1 show that growth velocity of pollen tubes differs from plant to plant. Some pollens develop shorter tubes than others in the same time, as it is shown also by the extreme values of pollen tube length. Pollens develop tubes with a velocity changing with time, since at various dates of pollen germination tubes of different length develop in unit time, that is, per hour velocity of tube growth varies from hour to hour. With pollen germination advancing in time differences increase, those between the shortest and the longest pollen tubes become greater and greater. The average per hour linear growth velocity of pollen tubes is 160 μ (1153 μ/7 hours).

In vivo conditions. After pollens placed on the styles, then styles removed

Table 1

Growth velocity of pollen tube in vitro

Duration of pollen tube growth in hours	Growth in hours							
	1	2	3	4	5	6	7	8
Pollen tube length in microns $\bar{x}$	—	64.2	429.6	655.2	794.8	908.2	1153.2	1092.0
$\bar{s}$	—	27.3	82.7	139.0	135.0	125.0	284.0	204.0
Extent of growth per hour in microns	—	64.2	365.4	225.6	139.6	113.4	245.0	—61.2
Lengths of the shortest and longest pollen tubes in microns	—	24.0	300.0	397.5	525.0	697.5	832.5	798.0
	—	112.5	510.0	865.5	1092.0	1125.0	1732.5	1368.0

at various dates, flowers were isolated. After fruits had riped it was established how long after pollination seeds began to develop in fruits. The speed of fertile particles of pollen tubes was determined by dividing the length of style parts cut off (here 2500 μ) by the time at which seeds were first found in fruits.

Table 2

Invivo speed of fertile

Duration of pollen tube growth (hours, minutes)	In case part of the style							
	0.30	1	1.30	2	2.30	3	3.30	4
Parthenocarpic fruits (per cent)		30	5			15		
Normal fruits (per cent)								
Number of seeds in fruits								

Results obtained during investigations are shown by Table 2. Data of Table 2 show that after pollens placed on the styles and before styles cut off at least 8 hours are required for fruits to set seed. This means that 8 hours were required for the fertile particle of the pollen tube to pass through the would-be cutting place, that is, to cover a distance of 2500 μ. Data of the table show, further, that only a few particles advance at that speed, as fruits set but one seed each. If styles are cut off 9 and 10 hours after pollination there are more seeds in fruits, that is, in a longer time more particles are able to cover the distance of 2500 μ, which means that their speed is lower, as the distance is the same as before. Speeds of fertile particles of pollen tubes are different, as

shown by the table as well. The quickest particles advance at a speed of 310 μ per hour (2500 μ/8 hours).

Staining with carmine acetic acid. With increase in the length of pollen tube the quantity of protoplasm contained by the pollen decreases. By the time the length of the pollen tube reaches 1700 μ, the pollen gradually becomes empty, and at right angles to the length of the tube diaphragms are produced, closing at the back the protoplasm passing forward, then, in vitro, the growth of the tube stops. By staining with carmine acetic acid it can be pointed out that the vegetative cell is generally in the tip of the tube, while the fertile particle, i.e. the two generative cells are located between the middle and the first third of the tube, in case of empty pollen as well. Thus, the distance between the tip of the increasing pollen tube and the fertile particles advancing in the tube is, in the given case, 850 μ (1700 μ/2).

Comparison between in vitro and in vivo results of pollen germination suggests that growth velocities of pollen tubes and speeds of fertile particles are not identical with the two ways of pollen germination. In vitro the fertile particles are not located in the tip of the increasing pollen tube. Since the speed of fertile particles is lower than the growth velocity of pollen tube, a difference in pathway occurs between the tip of the increasing pollen tube and

particles in the pollen tube

is removed after											
4.30	5	5.30	6	6.30	7	7.30	8	8.30	9	9.30	10
							15	15	15	40	45
							1	1	1	18	26

the fertile particles advancing in the tube, which in our case, at the given time is 850 μ. With the length of the part cut off the style, and the distance between the tip of the increasing pollen tube and the fertile particles advancing in the tube taken into account, further, by knowing the time with which seeds were first found in fruits, in vivo growth velocity of pollen tubes can be calculated. The length of the part cut off the style was 2500 μ, the distance between the tip of the pollen tube and the fertile particles 850 μ, seeds were found in fruits when at least 8 hours had passed from pollination to cutting off part of the style. When 850 μ, i.e. the distance between pollen tube tip and fertile particles is added to 2500 μ, i.e. the length of part cut off the style, and the result is

divided by 8, i.e. the number of hours required for fruits to set seed, in vivo growth velocity of pollen tubes will be obtained. Operations having been performed, the in vivo growth velocity of pollen tubes is found to be 420 μ per hour. The comparison between in vitro and in vivo growth velocities of pollen tubes shows that the average growth velocity of pollen tube is nearly three times as high in vivo as it is in vitro.

Conclusions

With the method discussed above in the vivo growth velocity of pollen tubes can be determined, provided that fertilization takes place even when the fertile particles have barely passed the place of cutting. If the state when the protoplasm containing part of the pollen tube passes the place of cutting is considered to be the precondition of fertilization, then the growth velocity of pollen tubes will be higher in vivo. Namely, the full length, 1700 μ, of the protoplasm containing part of the pollen tube should be added to the length of the part cut off the style, i.e. 2500 μ, and this sum is to be divided by 8, i.e. the number of hours required for the protoplasm containing part of the pollen tube to cover the distance of 2500 μ. In this case the per hour linear growth velocity of pollen tube in vivo is 525 μ (2500 μ + 1700 μ/8 hours). There are, however, problems, namely 1. does the in vivo growth velocity of pollen tube change in time the same way it does in vitro?, 2. does the distance between tube tip and fertile particles change in time in vivo? It is known, further, that in the pollen tube the vegetative cell is mostly in front followed by the two generative cells. Further investigations are to answer the following questions: what happens when the place of cutting falls 1. between the vegetative cell and the two generative cells, 2. between the two generative cells, 3. behind the two generative cells, but there is still plasm left in the tube part cut off. Naturally, these cases can be today but chance results, they cannot be either experimentally produced or reproduced at present.

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REFERENCES

Britikov, E. A.—Musatova, N. A.—Vladimirceva, S. V.—Витиков, Е. А.—Мусатова, Н. А.—Владимирцева, С. В. (1966): Влияние пролина и его антиметаболитов на прорастание пыльцы и рост пыльцевых трубок. Физиол. Раст., **13**, 978—987.

Conn, H. J.—Darrow, M. A.—Emmel, V. M. (196,0): Methods for pollen and pollen tubes. Staining procedures used by the biological stain commission, 197—201.

DANIEL, L. (1952): Pollenélettani vizsgálatok (Pollen physiolgical studies). I. Növénytermelés, **1,** 1—23.

DEMPSEY, W. H. (1962): Pollen tube growth in vivo as a measure of pollen viability. Science, **138,** 436—437.

DIBOLL, A. G.—LARSON, D. A. (1966): An electron microscopic study of the mature megagametophyte in *Zea mays.* Am. J. Bot., **53,** 391—402.

DMITRIEVA, A. N.—Дмитриева, А. Н. (1958): Перераспределение соединений пыльц, мещенных радиоактивными изотопами, между плацентой и развивающимися семенами. Бюлл. УНИИРСГ., **3,** 31—35.

GOLUBINSKY, I. M.—Голубинский, И. М. (1966): Взаемовплыв у сумисах пылку при пророщиванни на стучных середовыщах. Укр. Бот. Ж., **23,** 41—47.

HRISTOV, ST.—GENCHEV, SP.—Христов, Ст.—Генчев, Сп. (1964): Ижледвания варху покалване на прасека при пипера вав вразка с установяване на сортове, подхоясти за хибридни комбинации. Град и Лоз. Наука, **1,** 53—58.

KENDALL, W. A. (1967): Growth of red clover pollen. II. Elongation in vitro. Crop. Sci., **7,** 342—344.

KRISHNAMURTY, K. V.—APPARAO, K. (1958): Abnormal pollen tube development in a *Nicotiana* hybrid. Current Sci., **27,** 397—398.

LEHMAN, W. F.—PURI, Y. P. (1964): Factors affecting germination and tube growth of hand-collected and bee-collected pollen of alfalfa *(Medicago sativa* L.) on agar media. Crop Sci., **4,** 213—217.

LINCK, A. J. (1961): Chemotropism of pollen tubes in vitro in species of *Clivia* and *Haworthia.* Phytomorphology, **11,** 84—85.

LINSKENS, H. F. (1961): Biochemie der Inkompatibilität bei der Befruchtung der Blütenpflanze. Ber. Dtsch. Bot. Ges., **74,** 329—332.

LINSKENS, H. F.—ESSER, KL. (1959): Stoffaufnahme der Pollenschläuche aus dem Leitgewebe des Griffels. Proc. Ser. C. Biol. Med. Sci., **62,** 150—154.

LVOVA, I. N.—Львова, И. Н. (1958): Особенности прорастания пыльцы ржи в искусственных условиях. Бюлл. МОИП — отд. биол., **63,** 87—91.

LJU DA-CZUN—Лю Да-Цун (1959): Микроскопические наблюдения за взаимодействием пыльцевых зерен. Агробиология, **2,** 288—291.

MCWILLIAM, J. R. (1960): Pollen germination of *Pinus* as affected by the environment. For. Sci., **6,** 27—39.

MIHAJLOVA, P. V.—Михайлова, П. В. (1959): Сравнение особенностей роста пыльцевых трубок махорки в столбиках и на искусственной среде в связи с избирательностью оплодотворения. Труды УНИИРСГ., **4,** 117—128.

MIKI-HIROSIGE, H. (1964): Tropism of pollen tubes to the pistils. Pollen physiology and fertilization. North-Holland Publishing Company, Amsterdam, 152—158.

MILLER, M. K.—SCHONHORST, M. H. (1968): Pollen growth of alfalfa in vitro as influenced by grouping of grains on the medium and greenhouse versus field sources. Crop. Sci., **8,** 525—526.

MORTENSON, L. R.—PELOQUIN, S. J.—HOUGAS, R. W. (1964): Germination of *Solanum* pollen on artificial media. Amer. Pot. J., **41,** 322—328.

PALAMARCHUK, I. A.—Паламарчук, И. А. (1966): Разнокачественность пыльцы верхних и нижних цветков колоска в соцветии кукурузы. Вестн. Моск. Унив. сер. биол. почв., **1,** 69—72.

PFAHLER, P. L. (1965): In vitro germination of rye *(Secale cereale* L.) pollen. Crop. Sci., **5,** 597—598.

PFAHLER, P. L. (1967): In vitro germination and pollen tube growth of maize *(Zea mays* L.) pollen. I. Calcium and boron effects. Canad. J. Bot., **45,** 839—845.

ROSEN, W. G. (1961): Studies on pollen tube chemotropism. Amer. J. Bot., **48,** 889—895.

RÖBBELEN, G. (1960): Über die Kreuzungsunverträglichkeit verschiedener *Brassica*-Arten als Folge eines gehemmten Pollenschlauchwachstums. Züchter, **30,** 300—312.

SIMOLA, L. K. (1967): The effect of some non-protein amino acids on pollen germination and pollen tube growth in five species of the *Vicieae.* Planta, **77,** 287—297.

SMAGINA, M. A.—Смагина, М. А. (1958): О поведении чужеродной пыльцы на рыльцах кукурузы в связи с вопросом о пыльцевом менторе. Бюлл. УНИИРСГ., **3,** 50—54.

TUPY, J. (1959): Callose formation in pollen tubes and incompatibility. Biol. Plant., **1,** 192—198.

WALDEN, D. B.—EVERETT, H. L. (1961): A quantitative method for the in vivo measurement of the viability of corn pollen. Crop. Sci., **1,** 21—25.

WEILING, F. (1962): Über den Verlauf einer stochastischen Versuchsanalyse und ihre Bedeutung für die Pflanzenphysiologie. Ein Pollenkeimungsversuch als Blankoversuch. Biol. Zbl., **81,** 405—417.

WELK, S. R. M.—MILLINGTON, W. F.—ROSEN, W. C. (1965): Chemotropic activity and the pathway of the pollen tube in lily. Amer. J. Bot., **52,** 774—781.

ZDRILKO, A. F.—HAVZHINSKAYA, O. E.—Здрилко, А. Ф.—Хавжинская, О. Е. (1958): К вопросу о путях поступления и маркированной пыльцы в завязи. Бюлл. УНИИРСГ., **3,** 27—30.

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THE YEARLY DYNAMIC CHANGE OF CATALASE ACTIVITY IN THE VEGETATIVE PART OF APPLE VARIETIES

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With the aid of Frenyó's gasometric apparatus catalase activity of apple varieties has been studied for a long time on the field, in the phloic cambium and foliage leaves, at different parts of the day. When the foliage leaves appear, the activity of the phloic cambium and that of the leaves is high. The catalase activity of the leaves is the highest at the end of August and in the early days of September, while it is the lowest towards the end of May and in June. The catalase activity measured in the leaves at different dates was found divergent in the low, middle and upper leaves. With ageing the catalase activity generally decreases in the leaves, on the other hand, it increases in the phloic cambium. Within the varieties the minimum catalase activity of the phloic cambium was measured in January and February, while the maximum was evinced in July—August. The fluctuation between maximum and minimum is 6—9-fold. In the course of the day, the value of catalase activity is the least in the morning and the highest at noon and in the evening. On the basis of their catalase activity the varieties could not be separated from one another.

Introduction

According to the investigations of GRACANIN (1926), of the different plant parts, it is generally the foliage leaf in which the highest catalase activity is measured; only the cotyledon can surpass that value. BUSTINZA (1930) found the highest catalase activity in the leaf parenchyma. Within the large-surfaced tobacco leaf BARTA (1939) found that the edge and the apex were the most active. On the basis of the measurings of DELEANO *et al.* (1937) catalase activity is the highest in the apical leaves. TOSHCHEVIKOVA (1954) and co-workers performed catalase activity with the gasometric method and experienced the max. in early and late-maturing cotton. VASILYEVA (1956) examined the change of catalase activity in the leaves developing on the 7—9 nodes of the main shoot in four different vine varieties. The maximum was found in the flowering phase. According to OUJAN-SOU-ZHU (1963) the catalase activity in the vinestock became less with the decrease of temperature; during winter it reached the minimum when temperature was the lowest. With varieties of frost tolerance he experienced their catalase activity to be higher. KOZMA (1963) made investigations on vine varieties from May 17 to June 20. According to his data, in each case the activity of catalase was the highest in the lowest leaves and

it decreased upwards in the direction of the apex. The examinations were made between 7—9, 11—13 a.m. and 18—20 p.m.

With full knowledge of the above papers we began our own experimental investigations.

Material and Method

Of the material used for the experiments, the EM IV. apple had been propagated by earthing up, whereas Jonathan, Starking and Golden Delicious which all have roots of their own had been propagated with the layer method and then, in the autumn of 1963 they were planted in the nursery of the Model Farm of the College for Horticulture and Viticultur. The examinations were made on the shoots of the saplings cut back in the spring of 1964, and emerging from near the surface of the soil.

In our examinations FRENYÓ's (1962) gasometric method was applied. H_2O_2 of 1 per cent and O_2 freed by the catalase enzyme were measured in mm^3.

In an other version of the experiments samples of the same quantity were taken from the tissue of the phloem and of the cambium. After having removed the bark, a determined quantity of scrape was prepared both of the phloem and of the cambium. The number of repetitions was 12. The sample was taken from the internode between the 4—5 buds reckoned from the apex.

From the foliage-leaves, tissue slices taken with a cork-borer, were examined. The joint activity of 10—10-slices was measured in five repetitions and by doing so, the individual divergencies were practically excluded. The lowest, middle and upper leaves of the shoot were examined separately, still, in this paper, the average value of these is given thus, which made us obtain data of the whole foliage.

Data referring to varieties and to the points of time are shown in diagrams. The measuring of catalase activity was performed in shadow corresponding with the current temperature.

Adapted from SVÁB (1967) the extreme values were analysed with the aid of the Dixon test.

The coefficient variation, CV in each repetition was 14.4 per cent with the apple M. IV; in the case of the own rooted Jonathan it was 14.4 per cent; with the own rooted Starking, this was 14.6 per cent and with the alike Golden Delicious, it was 15.7 per cent taken all as a yearly average. When measurings are made in field, this scattering can be considered reasonable.

Results

The yearly dynamic changes of catalase activity of phloem and of cambium. The catalase activity of the M. IV. apple slightly increased from 28 November to 18 December 1964, then, from 18 December to 8 March it was of about the same value due, most probably, to the plants being at rest. From 28 March to 4 October an increase can be observed again; from this time on the value decreased continuously. The minimum of catalase activity was in January and in February, while its maximum was in August—September. The value of the maximum was eight times higher than that of the minimum. Throughout the year, the result of measurings between 8^h a.m. and 10^h a.m. was, in general, lower; that of measurings at noon and in the afternoon, was higher (Fig. 1).

The catalase activity of the own rooted Jonathan, increased from the 8 December 1964, and then it decreased to 28 December; its value was relatively steady till 28 March; from that time on it began to increase continuously till

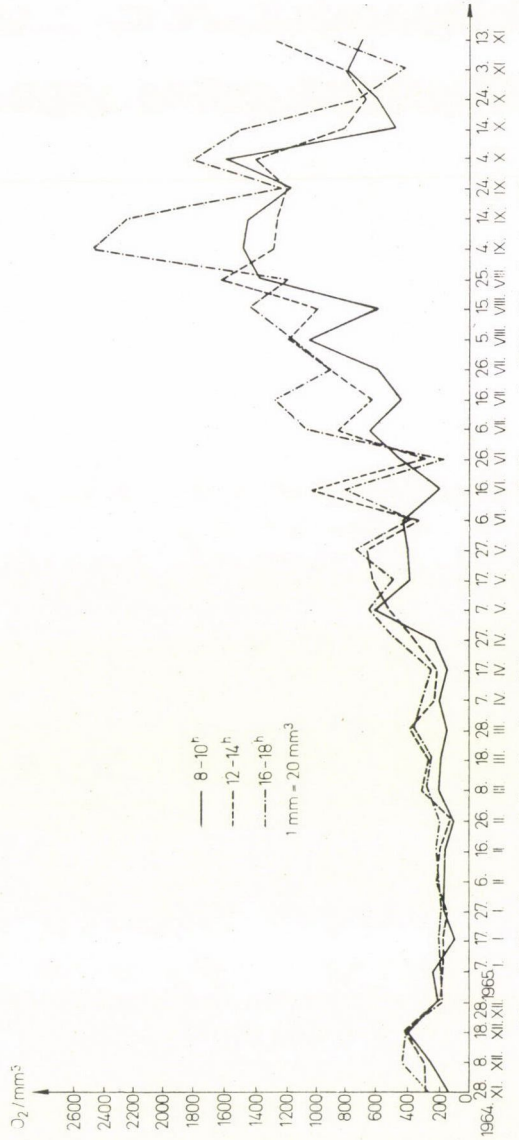

Fig. 1. Catalase activity in the phloem cambium of the apple EM IV. during the year

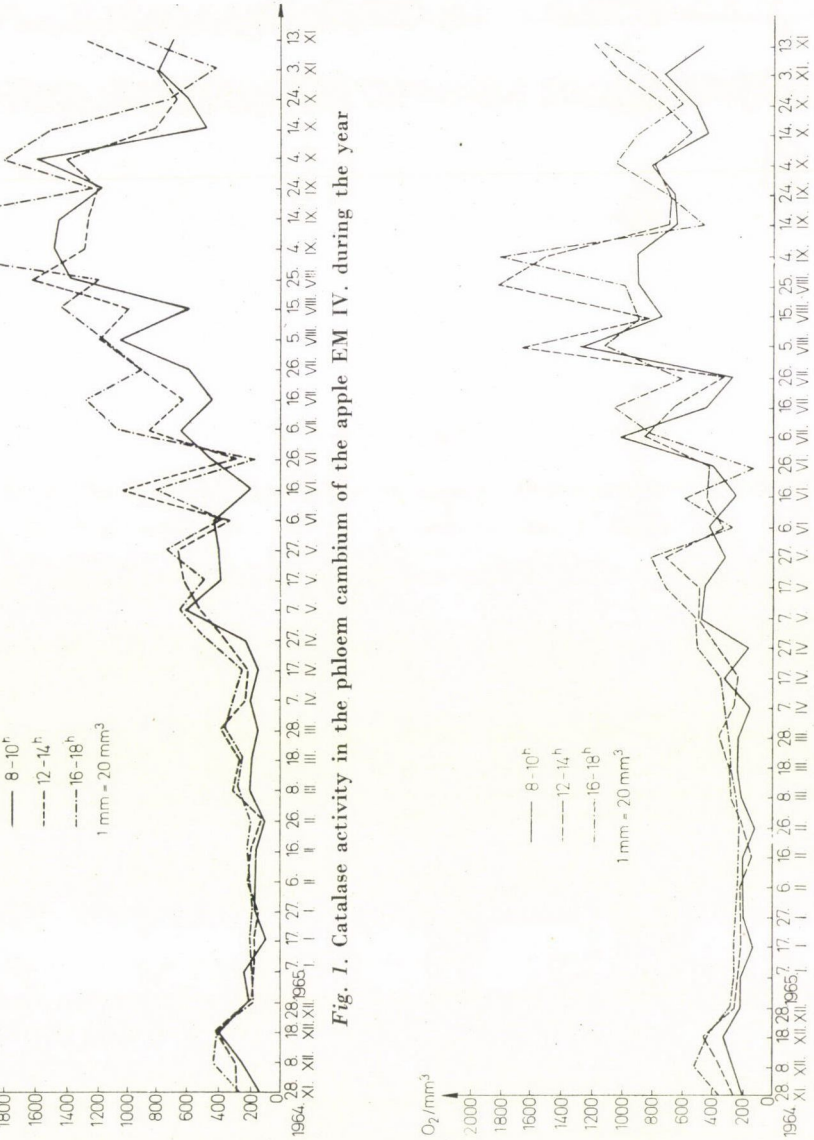

Fig. 2. Catalase activity in the phloem cambium of Jonathan having its own roots, during the year

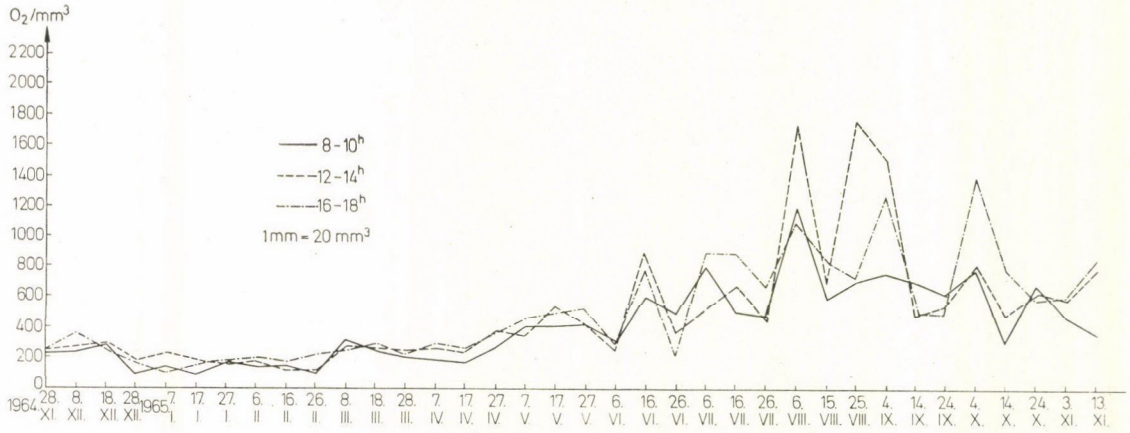

Fig. 3. Catalase activity in the phloem cambium of Starking with roots, during the year

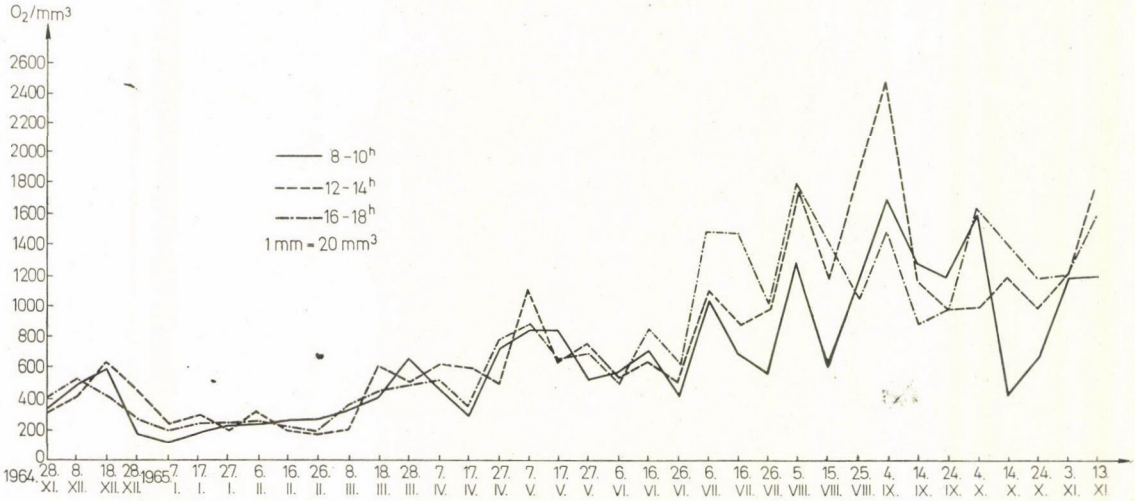

Fig. 4. Catalase activity in the phloem cambium of Golden Delicious having roots, during the year

4 September. This was followed by a decrease till the end of vegetation. The minimum was experienced in January and February, while the maximum was recorded in July and August. The maximum became six-fold as much as the minimum. In the Jonathan, too, the catalase activity measured in the morning till $8-10^h$ was the least, except one or two cases, during the year. With that variety at the time of maximum, the data obtained at noon were the highest (Fig. 2).

The catalase activity of the own rooted Starking gradually decreased from 28 December to 8 March. Then it began slowly to increase till 16 June; from that time on the increase was abrupt, then from 4 October the value decreased again. The minimum was observed in January—February, the maximum in August—September. The maximum became seven times as much as the minimum. The catalase activity measured in the morning was lower than at noon and in the afternoon, throughout the year (Fig. 3).

The catalase activity of the own rooted Golden Delicious decreased from 18 December to 28 December, then it became relatively steady. From 8 March it increased gradually till August 25 and then it began to decrease. The minimum was in January—February, the maximum in July and August. The maximum became the nine-fold of the minimum. The data obtained in the morning at $8-10^h$ are here, too, lower than those measured at $12-14^h$ to $16-18^h$ (Fig. 4).

Yearly dynamic change of the catalase activity in the leaves. When examining the foliage leaves, the catalase activity of the lower, middle and upper leaves was measured. In the figures the foliage-activity of the varieties is demonstrated so as to show also the daily change.

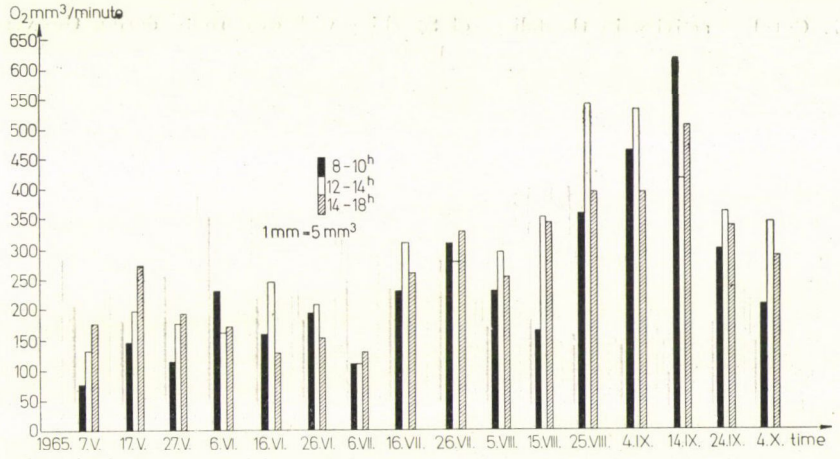

Fig. 5. Catalase activity in the foliage of the apple EM IV during the vegetation period

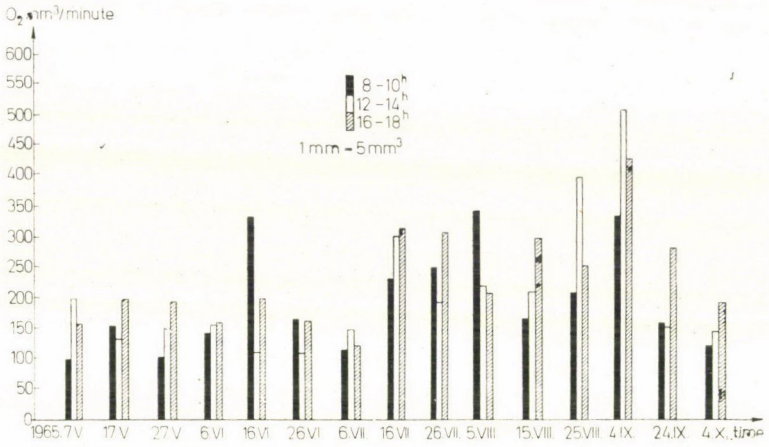

Fig. 6. Catalase activity in the foliage of Jonathan with own roots, during the vegetation period

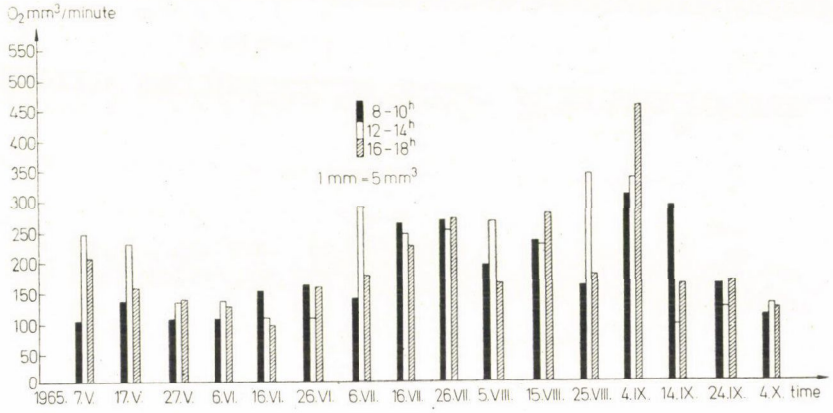

Fig. 7. Catalase activity in the foliage of Starking with own roots, during the vegetation period

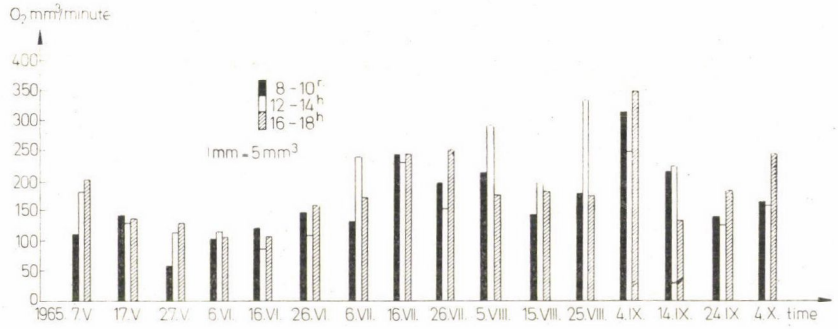

Fig. 8. Catalase activity in the foliage of Golden Delicious with own roots, during the vegetation period

The catalase activity of the M. IV apple. It was high at the appearance of the leaves (May 7—17), from this time on it was decreasing. The maximum became the threefold of the minimum. The low, middle and upper leaves were different from one another. At the beginning of vegetation the highest activity was found in the upper leaves, at midsummer time this could be seen in the lowest leaves, while during the autumn a higher activity was observed in the middle leaves. Except two days of the examination, the catalase activity measured between 8^h and 10^h a.m. was the least, while the highest was that between $12—14^h$ and $16—18^h$ (Fig. 5).

The catalase activity of the own rooted Jonathan was the lowest on the 6th July; on the 4th of September it was the highest. The maximum was three times more than the minimum. Except two cases, the catalase activity measured in the morning at $8—10^h$ was the lowest while the highest was that established between $12—14^h$ and $16—18^h$ (Fig. 6).

The catalase activity of the own rooted Starking was the least on the 16th of June; the highest was measured on the 4th September. Here, too, the maximum was three times more than the minimum. With the exception of September 14, the value measured in the morning at $8—10^h$ was the lowest, those measured between $12—14^h$ and $16—18^h$ were the highest (Fig. 7).

The catalase activity of the own rooted Golden Delicious is high at the beginning of vegetation; it decreases in June, increases in July, there is a slight decrease in August, while on the 4th of October it was still high. The maximum became the double of the minimum. The least value was measured between 8 and 10 hours a.m., all the others were higher (Fig. 8).

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REFERENCES

Barta, L. (1939): Enzymuntersuchungen während der Trocknung des grünen Tabake, Zf. Unters. Lebensmittel., **78,** 322—327.

Bustinza, F. (1930): Zur Verteilung der Katalase in den Pflanzen. Bot. Soc. Espan. Hist. Nat., **30,** 161—164.

Deleano, Nt. *et al.* (1937): Contribution á l'étude de la catalase végétale. Bull. Soc. Chim. Biol., **19,** 898—910.

Frenyó, V. (1962): Neues Verfahren zur Feststellung der Katalaseaktivität von Pflanzen am freien Feld. Annales Univ. Scient. Bp. Sectio Biol., **5,** 131—136.

Gracanin, M. (1926): Ein Beitrag zur Kenntnis der Katalasewirkung bei autotrophen Pflanzen. Biochem., **168,** 429—442.

Oujan, Sou-Zhu—Оуян, Шоу-Жу (1963): Некоторые данные по Физиологии морозостойкости виноградного растения. Физиол. Раст., 10, 366—368.

Kozma, P. (1963): A szőlő termékenységének és szelektálásának virágbiológiai alapjai (Flower-biological bases of the productivity and selection of vine). Akadémiai Kiadó, Budapest.

Sváb, J. (1967): **Biometriai módszerek a mezőgazdasági kutatásban (Biometrical methods in agricultural research). Mezőgazdasági Kiadó, 498.**

Toshchevikova, A. G.—Тощевикова, А. Г. (1954): Биохимические особенности скороспелых и позднеспелых сортов хлопчатника на фоне факторов, ускоряющих их развитие. Т. и. Среднеаз. ун-та, **53,** 7—88.

Vasilyeva, Z. V.—Васильева, З. В. (1965): Превращение углеводов и активность ферментов у винограда в условиях Московской области. Зап. Моск. гос. пед. ин-та, **97,** 133—166.

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CLASSIFICATION OF PROGENY-TESTED BULLS

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On the results of progeny-tests carried out in Denmark and Hungary on forty-four Red Danish as well as five Hungarian-spotted × Jersey (F_1) bulls, the authors have investigated the question, whether it may change the order of sequence and if so, to what extent, if the most unproductive individuals of their progeny would uniformly and proportionally be sorted out at any time? It was established, that to sift out the lowest producing individuals which come to 10, resp. 20 per cent of each progeny group, is at any time permissible without losing the possibility of identification of bulls of extremely high or poor transmitting ability.

Introduction

There are some disturbing problems arising constantly in the effective fulfilment of the progeny-testing of bulls. It is beyond doubt that keeping those female offsprings, the productivity of which is extremely poor, is rather expensive and uneconomical. Nowadays this question is of great importance because to establish a modern and mechanized dairy-farm serving as progeny-testing station would really carry to the debit of high investment and sinking loans of each stall of the cows. The inauguration of modern and mechanized technology definitely requires the rentability of the animal production concerned. It is prohibitive therefore, to keep the low producing individuals which results a considerable loss, even if the progeny-test of the bulls under study would otherwise justify it.

Material and Method

From the consideration above, the question, although still unelucidated, arises automatically: may it change the classification of bulls tested and if so, to what extent, if one would in some respect leave the most unproductive individuals among their progenies uniformly out of consideration. In other words: is it any time allowable to let such animals to be sifted out?

To study this problem equally important for economical and genetic reasons, the following experiments were carried out: the change in classification of forty-four Danish Red bulls (15—20 females per bull) progeny-tested by a centralized method in Denmark, 1963/64 in the following cases.

a) Leaving aside 10 per cent of the most unproductive individuals, on the basis of the lactational milk-fat production (kg),

b) 20 per cent,

c) 30 per cent of them.

Results

It was found that, in general, there were no apparent changes in the classification of bulls giving the highest and lowest progeny-test results as compared to the official classification of the total group. In each case the best 25 per cent and the poorest 25 per cent of the bulls remained the best or rather the lowest, respectively.

Although the classification of the bulls has changed in 66 per cent, 82 per cent and 89 per cent of the cases, the deviation from the original classification was apparently low: in average

a) ± 0.45; b) ± 0.68; c) ± 0.95 — number of classification.

The same study was accomplished based on the data of the progeny-groups of the R_1-lactating Hungarian-spotted cattle having a 25 percentile Jersey gene-proportion of five Hungarian-spotted $\times$ Jersey crossed F_1 bulls as well. The results are in harmony with the previous observations for as much as:

	In cases				
	Base	a)	b)	c)	
by Dani	I. (n = 20)	I. (n = 18)	I. (n = 16)	II. (n = 14)	place
by Cinke	II. (n = 12)	II. (n = 11)	II. (n = 10)	I. (n = 8)	place
by Bánát	IV. (n = 16)	III. (n = 14)	IV. (n = 13)	III. (n = 11)	place
by Dicső	III. (n = 35)	IV. (n = 32)	III. (n = 28)	IV. (n = 25)	place
by Dávid	V. (n = 25)	V. (n = 22)	V. (n = 20)	V. (n = 17)	place

has been taken.

The classification has changed in the instances of 40; ø (zero) and 80 per cent, respectively. The values of deviations proved to be low: in average

a) ± 0.20; b) ± 0.00; c) ± 0.40 — number of classification.

Hence, according to our present observations, to sort out 10 or 20 per cent of the lowest producing individuals of each progeny-group, is permissible at any time without losing the possibility of identification of bulls of extremely high or poor transmitting ability.

Further investigations are planned to establish the margin itself, beyond which there might be a serious fault caused by the reduction of the number of the progeny.

Acknowledgement

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REFERENCES

HORN, A. (1966): Genetic and environmental improvement — achievements and prospects. Proc. 9th International Congress of Animal Production, Edinburgh, 168.

HORN, A. (1967): Genetikai és környezeti előrehaladás az állattenyésztésben (Genetic and environmental improvement in animal husbandry). MTA Agr. Tud. Oszt. Közl. (Budapest), **26**, 513.

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EFFECTS OF PLOT SIZE, STAND DENSITY AND STATE OF FLOWERING ON WILD BEES POLLINATING LUCERNE

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During the examinations we have succeeded in developing a survey method providing nearly static results. Effects by the intensive moving of pollinators were not eliminated by earlier investigations. In this country it is this why the results of the two methods differ, although they can be compared by means of a table. Small sized lucerne fields show but slightly higher abundance in wild bees than large fields. In large fields the amount of species with a short flight period is lower, while abundance of the other groups is slightly higher than — or the same as — in small lucerne fields. In lucerne fields of thick stand there are fewer pollinators than in thin stands. Abundance of the group with a short flight period hardly shows any difference while that of other groups is significantly lower in thick stands. The number of pollinators is the highest at the time when lucerne fields are in full blossom; the abundance of the flight groups is in connection with the intensity of their flight.

Introduction

Examination of the fertilization conditions of lucerne called the attention of researchers to the pollinating insects several decades ago. The activity of domestic honey bees was first studied. Literature concerning the role of honey bees in pollinating lucerne is highly inconsistent, as the useful activity of honey bees is decisively influenced by the ecological conditions. On the basis of MÓCZÁR's (1961d) and our own studies (BENEDEK 1967) it is known that the pollination of lucerne depends in Hungary on the activity of wild bees; investigations made by BÖJTÖS (1966) also suggest that in Hungary domestic honey bees contribute to the seed production of lucerne only to a small extent even under special conditions.

Following some previous observations STAPEL (1943) was the first to perform detailed studies on wild bees pollinating lucerne. Several years later further basic studies (LINSLEY 1946, ÅKERBERG—LESINS 1949, POPOV 1951) were published. Results of the first one-and-a-half decade of investigations were summarized by BOHART (1957, 1960). As a result of MÓCZÁR—BÖJTÖS's (1957) studies (MÓCZÁR 1959, 1961a, 1961b, 1961c) in Hungary many details have become clear. Both the earlier (see above) and later investigations (POPOV 1956, IUGA—SCOBIOLA 1960, PONOMAREVA 1960, LECOMTE—TIRGARI 1965, SOLINAS—BIN 1965 etc.) were aimed at studying the composition and number of pollinator populations as well as the activity of pollinators. The

authors conducted their investigations in some lucerne fields only, therefore reports on the relation of the structure and abundance of the pollinator population to the agronomical factors are very infrequent informing only in terms of observations (e.g. MÓCZÁR—BÖJTÖS 1957).

On the basis of preliminary surveys made in 1966 and results of earlier researches the Plant Protection Service carried out extensive investigations from 1967, which were aimed mainly at studying problems left open by earlier researches. To achieve the aim was enabled by setting the pollinators in groups which were nearly uniform biologically (BENEDEK 1968a) and by the high number of lucerne fields and their testings. Author is indebted to four entomologists: J. Komlódi (Tarhos), L. Bánk (Mikepércs), P. Andrásfalvy (Budapest) and E. Wilhelm (Győr) who took part in the investigations and to Mrs. P. Benedek for helping him in his work.

Material and Method

In the course of investigations carried out in four counties of the Hungarian Great Plain (Pest, Szolnok, Hajdú and Békés), as much as 5771 wild bees have been collected and recorded respectively in lucerne fields and 103 surveys were made in the location of 93 villages. The total acreage of lucerne fields visited during the investigations was 2455 ha which is about 1/5 of the total acreage of lucerne sown for seed production in the counties studied. The total acreage of strips of land surveyed in the studied lucerne fields was 24 515 m².

Method of surveying. In order to achieve the aims such a method had to be chosen which makes possible the calculation of static results and simultaneous determination of the number and specific composition of a pollinator population. During our work we endeavoured to make as many surveys as possible — in uniform regional distribution as far as it was possible.

Among the methods used in studying wild bees pollinating lucerne (LECOMTE 1962), the land strip survey proved to be the most suitable. This method has been elaborated on the basis of preliminary studies performed in 1966 and tested in 21 lucerne fields of north-western Hungary. This method is called simple strip-method.

A steady, slow advancement is the most important condition of our method. Speed was determined in 10 m/sec, i.e. 600 m/hour covered by the surveyor who made recordings. Namely, informational studies suggest that this speed is low enough to prevent a trained eye from missing even one single wild bee. In addition, this speed was found not to disturb the activity of wild bees. While advancing we watched the lucerne field by looking forward in an angle of 45°, thus — according to our measurements — a 50 cm wide strip was kept in sight. With a quick and sure movement the surveyor collected the wild bees found in — or flying into — the strip with a butterfly net, while keeping an eye on the strip of land surveyed to be able to notice the wild bees that might have been started. With the necessary practice obtained at least the genus of wild bees can be recognized even while flying. The few bees we could not catch were recorded and added to the result. Wild bees are distributed rather evenly on the area, this is why — according to our observations — their activity was not disturbed even by the collecting of the specimens falling into the surveyor's hand. The surveyors should be well trained collectors; it is an important basic principle of this method. In order to obtain the required practice, from the beginning of spring we spent at least one day a week in collecting wild bees. In the course of our investigations an area of 300 m² — though sometimes only 150 m² — was usually surveyed in each lucerne field. Essential data were recorded on sheets prepared (stencilled) in advance.

Method of evaluation. The collected material has been identified by the author, however, the list of species is going to be published in another paper of us. The present paper — instead of giving the names of species — deals with flight-groups established by the author (BENEDEK 1968). Namely, a long list of species names renders the recognition of correlations very difficult, or even impossible, while flightgroups make them easy to understand.

All surveys made in lucerne fields were grouped according to predetermined aspects on the basis of data recorded on the spot. Each survey could be placed into one of the groups. Data of lucerne fields placed into the same group were averaged by using weighted means. In some cases when a group included only a couple of surveys, data were not evaluated. On the basis of data obtained in our investigations the percentage proportion and amounts per ha of flight-groups have been calculated.

The number per unit area of wild bees pollinating lucerne is influenced by a great many factors of which only some of the most important ones are considered in our present paper. Owing to the great number and high variability of active components, statistical trials made in relation to the individual components showed few significant differences in case of $p = 5$ per cent, therefore statistical values are not given in the following tables. In our case, however, due to what was said before, also tendency-like correlations relative to the individual components can be evaluated. This is acceptable because results of investigations made separately by a number of surveyors in different regions (counties) of the country with the same method show identical tendencies. The statistical reliability could have been increased by raising the number of surveys, which is, however, not feasible in our case. Even so, the number of our surveys (103) exceeds those made by others. The investigations have been going on both in 1968 and 1969, but the wheather conditions during the survey had been uniformly advantageous in 1967 only; therefore, only the 1967 data have not been influenced decisively. This is why only this year's data made reliable conclusions possible concerning the phenomena dealt with below.

Methodological considerations. In order to eliminate the time factor it would be theoretically the best to be able to count the wild bees in a given area at a single moment. It is, however, impossible with surfaces larger than 0.5 m². Still, the single strip-method is close to optimum conditions, since parts of the area were watched for a single moment each; subsequent parts of the area were observed in subsequent moments. The activity of wild bees does

Table 1

Comparison of Móczár's strip-method to the simple strip-method

Place and time of investigations, 1967	Simple strip method Number of bees per ha	Móczár's strip method Number of bees per ha	Móczár's strip method in the percent of the simple strip method
Báránd, July 31.	651	977	150
Bősárkány, July 24.	750	980	130
Szany, July 25.	828	1190	138
Érd, July 31.	830	1574	184
Kevermes, August 2.	912	1162	182
Ceglédbercel, July 14.	1140	2347	205
Kamut, July 21.	1193	3228	275
Nagyszénás, August 9.	1286	3034	225
Kartal, August 1.	1303	3423	287
Újrónafő, July 18.	1402	3716	265
Hajdúnánás, July 27.	1727	3914	220
Csorvás, August 9.	1793	4011	224
Vésztő, July 27.	1989	4401	221
Osli, July 31.	3129	7570	240
Kisújszállás, July 14.	6718	14257	212

not virtually change within narrow limits of time (BENEDEK 1967), thus our method is nearly identical in its logics with the total area being observed in a single moment. Due to what have been said our method provides a nearly static result.

In their studies performed in Hungary MÓCZÁR—BŐJTÖS (1957) and MÓCZÁR (1961c) used a method (subsequently called Móczár's strip-method) different from that described above. By passing along the diagonal of a lucerne field they marked out ten patches of 10 m^2 each by means of two 10 m long strings marked at every meter and 4 stakes, and — while watching each 1m^2 square for 30 seconds — recorded the number of wild bees found there and flying in. In our opinion, however, the 30 second interval is too long for obtaining a static result with insects moving so quickly. This is why results of the two methods cannot be considered identical.

In order to create the conditions of a possible comparison investigations have been carried out by using both methods in a number of lucerne fields in different regions of the country (Table 1). The data show that in case of a low number of wild bees the deviation is unimportant, with a higher number of wild bees it increases significantly, then slightly decreases again (Table 1). As a result of his surveys made in 10 different regions MÓCZÁR (1961c) found an average of 4.2 wild bees per 10 m^2, which means an abundance of 4200/ha. According to Table 1 this corresponds to about 1800/ha, when the simple strip-method is used.

The reliability of the simple strip-method is proved by the fact that, while in Móczár's strip-method the time of watching a piece of field is much longer than in the simple strip-method, the difference originating from the constant moving of bees — i.e. static requirements are not being met — results in values which are only about twice as high (Table 1). Thus, in the simple strip-method time of watching a piece of land is so short that the error given by the constant moving of bees can be virtually neglected.

Results

Relation of the size of plots to the number of pollinators per ha and to the composition of population. Indeed, the results of our investigations show (Table 2) that the abundance of wild bees is higher in small plots than in large ones, but the difference is somewhat smaller than has been suggested by the results of seed production and theoretical considerations. This implies that among the factors causing the low seed production observed in large plots there are some very important ones beyond the decreased abundance of wild bees — at least in the Hungarian Great Plain.

The proportion and amount of the group with a short flight period show a tendency decreasing with the increase in the size of plots (Table 3), despite that these insects make their nests in lucerne fields (BENEDEK 1968a). The

Table 2

Relation of the size of plot to the number of pollinators per ha

Plot size ha	Szolnok		Békés		Hajdú		Pest	
	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n
1— 3	2743	6		1	1836	4		1
3—17	2222	13	1465	10	1606	13	1509	7
17—35	2027	7	1347	8	1572	7	1105	11
35<	1809	10		1		1		1

Table 3

Relation of plot size to the percentage proportion and number of flight-groups per ha

Flight group	Plot size ha	Szolnok		Békés		Hajdú		Pest	
		%	wild bee/ha	%	wild bee/ha	%	wild bee/ha	%	wild bee/ha
Species of short flight period	1– 3	66	1810			56	1028		
	3–17	51	1133	40	586	21	337	43	647
	17–35	51	1030	37	498	15	235	60	663
	35<	48	689						
Species of medium flight period	1– 3	3	72			1	18		
	3–17	2	44	6	88	2	36	2	30
	17–35	4	81	6	81	5	90	3	33
	35<	2	36						
Bivoltine species of long flight period	1– 3	27	740			15	275		
	3–17	44	997	48	703	57	915	50	754
	17–35	42	808	51	686	74	1173	36	397
	35<	48	864						
Continuously multiplying species of long flight period	1– 3	4	109			28	478		
	3–17	3	66	6	88	19	310	5	75
	17–35	3	60	6	81	6	88	2	11
	35<	2	36						

decrease is presumably connected with the regular insecticide-treatment of the large plots, even at time of inflorescence, while small plots are treated less frequently. Thus, insecticides, even those sparing the honey bees, destroy the wild ones (BENEDEK 1968a).

According to the majority of the data of Table 3 the number of pollinators with a medium flight period shows a slightly increasing tendency with the increase in plot size. Some data, however, do not show this tendency, thus proving that there is but a slight relationship between the abundance of species of medium flight period and the size of plots.

Bivoltine species with a long flight period do not show any close relation to the size of plots (Table 3). Some data show, however, a slight increase in number as a result of an increase in the size of plots.

The number of the continuously multiplying wild bees with a long flight period shows a decreasing tendency with the increase in plot size (Table 3). This is due to the well-known fact that the species "Bombus" prefer red clover — and

in Hungary also *Labiatae*, *Compositae* and *Boraginaceae* — to lucerne (BENEDEK, nonpublished). The above plants are available to the species Bombus even at the flowering time of lucerne and thus exert a strong competitor effect. At the same time — according to our observations — these species usually frequent the outer parts of lucerne fields. This can be observed in large plots too, hence their number per ha is higher in smaller plots than in large lucerne fields.

Effect of the planting density on the number of pollinators per ha and on the composition of the population. In the counties of Békés and Pest every plot examined was of the same planting density — except for one or two lucerne fields — therefore data cannot be evaluated here. However, on the basis of data obtained in the counties of Szolnok and Hajdú some conclusions can be drawn.

Data of Table 4 show that the number of wild bees is relatively low in dense stands* and high in rare ones, that is, rare stands are favourable to pollinators.

Abundance of short flight pollinators nesting in lucerne fields does not show any relation to the planting density; other pollinator groups, however, are present in a lower number in dense stands than in rare ones. These bees do not feed exclusively on lucerne, thus, when the conditions are not favourable they frequent the lucerne fields in a lower number. In lucerne fields of rare stand the flowers are more easily available for wild bees and, as not only the uppermost flowers can be frequented, a higher number of pollinators are supposed to contribute to unproportionally higher yields.

Table 4

Relation of the planting density of lucerne to the number of pollinators per ha and percentage proportion and amount of flight groups

County	Stand	Wild bee/ha		Species of short flight period		Species of medium flight period		Bivoltine species of long flight period		Continuously multiplying species of long flight period	
		$\bar{x}$	n	%	wild bee per ha	%	wild bee per ha	%	wild bee per ha	%	wild bee per ha
Szolnok	dense	1528	14	59	915	6	91	33	492	2	30
	rare	2556	22	49	1328	2	52	45	1172	4	104
Hajdú	dense	1153	12	27	301	3	33	55	647	15	172
	rare	2048	15	19	388	3	61	61	1231	18	368

* Lucerne fields are considered to be of thick stand when the soil surface is completely shaded by plants; in thin lucerne fields, on the contrary, the plants do not completely cover the ground. Our investigations were carried out in lucerne fields sown originally in closely spaced rows.

Relation of the state of inflorescence to the number of pollinators per ha and to the composition of the population. In the county of Békés plots in full blossom were examined only, therefore data cannot be evaluated here; but data obtained in the counties of Szolnok, Hajdú and Pest are suitable for conclusions to be drawn.

In the three counties studied the lucerne fields were made flower at different dates. Flowering took place in the county of Pest in July, in Szolnok

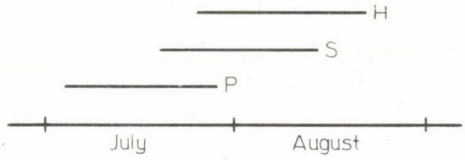

Fig. 1. Flowering time of lucerne fields in 1967 in the counties of P = Pest, S = Szolnok, H = Hajdú

from the middle of July to mid August and in Hajdú between the end of July and the end of August.

Abundance per ha of all of the pollinators (Table 5) is the highest when lucerne fields are in full blossom;* at the beginning of flowering it is somewhat lower than at the end.

Early July is the time when mass activity of pollinators of short flight period begins; their flight culminates in the middle of July (BENEDEK 1968a) and from that time on their number decreases. Their number was the highest when lucerne fields were in full blossom (Table 6), only the data of the county of Pest show different trends due to an earlier flowering compared to the counties of Szolnok and Hajdú. Species with a short flight period were present always in a lower number at the beginning of flowering than at the time of full blossom. At the end of flowering their abundance depends on the time of flowering. In lucerne fields with early inflorescence (flowering is finished by

Table 5

Relation of the number of pollinators per ha to the state of flowering

State of flowering	Szolnok		Hajdú		Pest	
	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n
Beginning of flowering ..	1630	4	1130	5	488	2
Full blossom	2305	29	1723	17	1358	16
End of flowering	1500	3	1406	5	1336	2

* Lucerne fields were considered to be in full blossom when at least 30 per cent of the flowers were already — or still flowering.

Table 6

Relation of the state of flowering to the percentage proportion and number of flight-groups per ha

Flight group	State of flowering	Szolnok		Hajdú		Pest	
		%	wild bee/ha	%	wild bee/ha	%	wild bee/ha
Species of short flight period	Beginning of flowering	47	467	26	295	34	164
	Full blossom	50	1152	27	465	47	638
	End of flowering	34	548	17	240	50	668
Sp. of medium flight period	Beginning of flowering	10	163	2	23	0	0
	Full blossom	3	69	4	68	3	40
	End of flowering	0	0	3	42	1	13
Bivoltine sp. of long flight period	Beginning of flowering	40	653	68	768	67	323
	Full blossom	44	1015	51	878	44	599
	End of flowering	60	923	65	910	48	642
Continuously multiplying sp. of long flight period	Beginning of flowering	3	50	4	44	0	0
	Full blossom	3	69	18	312	3	81
	End of flowering	2	29	15	214	1	13

the middle of July) they may be present in a higher number at the end of flowering than at the time of full blossom. Thus their proportion and abundance is in connection with the intensity of their flight.

The flight intensity of species of medium flight period gradually decreases with the progress of flowering, since their flight is finished by mid August (BENEDEK 1968a). However the odour of lucerne fields is less at the beginning of flowering and, since it is not here that these species make their nests, their number is the highest when lucerne fields are in full blossom.

The second generation of bivoltine species with a long flight period takes part in the pollination of lucerne; these pollinators appear in a great number in July and their activity increases till the beginning of August (BENEDEK 1968a). Their abundance is higher when lucerne fields are in full blossom than at the beginning of flowering, but their number is the highest at the end of flowering. Thus, their number depends on the intensity of their flight.

The flight of continuously multiplying pollinators of long flight period is nearly of the same intensity during the whole period of lucerne flowering (BENEDEK 1968a). Increased odour seems to have only a moderate effect on them owing to the high degree of polytropism they possess (see above), hence their number — though the highest at the time of full blossom — shows but a slight connection with the state of flowering.

Conclusions

The abundance of pollinators shows a decreasing tendency with the increase in plot size; there are, however, other factors too which play an important role in producing the relatively low yields of large plots. It seems to be necessary to develop a plot size of about 15 ha and to reveal and improve the other factors. Rare stands of lucerne are favourable to wild bees. Therefore, in order to exert a beneficial effect on the abundance of wild bees, conditions under which plants develop primarily from a generative point of view, thus forming a rare stand — should be created in lucerne fields for seed production. It seems to be reasonable to sow seed lucerne at a double row spacing instead of the usual 12 cm. From the point of view of species with a short flight period nesting in lucerne fields, hoed lucerne fields do not seem to be favourable, as long as weed control has to be carried out mechanically. The number of pollinators is the highest at the time when lucerne fields are in full blossom; the abundance of the individual groups depends, however, on the intensity of flight. Therefore it is necessary to adjust the time of flowering to the flight period of the must abundant flight group.

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REFERENCES

Åkerberg, E.—Lesins, K. (1949): Insects pollinating alfalfa in Central Sweden. Ann. Roy Agr. Coll. Sweden, **16,** 630—643.

Benedek, P. (1967): Új ismeretek a lucernát megporzó vadméhekről (New information on wild bees pollinating lucerne). Budapest, MÉM. Inform. Közp., 1—83.

Benedek, P. (1968a): The flight period of wild bees *(Hymenoptera, Apoidea)* pollinating lucerne, and its plant protection aspects. Acta Phytopat. Acad. Sci. Hung., **3,** 59—71.

Benedek, P. (1968b): A lucernát megporzó vadméhek *(Hymenoptera, Apoidea)* vizsgálatának növényvédelmi tanulságai (Plant protection lessons drawn from the examination of lucerne pollinating wild bees [*Hymenoptera, Apoidea*]). Növényvédelem, 4,201—218.

Bohart, E. G. (1957): Pollination of alfalfa and red clover. Ann. Rev. Ent., **2,** 355—380.

Bohart, G. E. (1960): Insect pollination of forage legumes. Bee World, **41,** 57—64, 85—97.

Bőjtös, Z. (1966): Honey bee activity in alfalfa (*Medicago sativa* L.) pollination in Hungary. Acta Agronomica Acad. Sci. Hung., **15,** 215—221.

Iuga, V. G.—Scobiola, X. (1965): Sur quelques Apoides pollinisateurs des luzernes. Trav. Mus. Hist. Nat. "Gr. Antipa", **2,** 245—257.

Lecomte, J. (1962): Techniques d'étude des populations d'insectes pollinisateurs. Ann. Abeille, **5,** 202—213.

Lecomte, J.—Tirgari, S. (1965): Sur quelques pollinisateurs des légumineuses fourragères. Ann. Abeille, **8,** 83—93.

Linsley, E. G. (1946): Insects pollinators of alfalfa in California. J. Econ. Ent., **39,** 18—29.

Móczár, L. (1959): The activity of the wild bees (Hym. Apoidea) in Hungarian lucerne fields. Acta Agronomica Acad. Sci. Hung., **9,** 237—298.

MÓCZÁR, L. (1961a): A lucernát megporzó magyarországi méhalkatú fajok — *Hym. Apoidea* — (Hungarian wild bees *(Hym. Apoidea)* pollinating lucerne). Fol. Ent. Hung., **14,** 217—236.

MÓCZÁR, L. (1961b): The distribution of wild bees in the lucerne fields of Hungary *(Hymenoptera, Apoidea)*. Ann. Hist. Nat. Mus. Nat. Hung., **53,** 451—461.

MÓCZÁR, L. (1961c): A hazai lucernások vadméheinek mennyisége (The number of wild bees *(Hym. Apoidea)* in lucerne fields of Hungary). Állatt. Közlem., **48,** 95—105.

MÓCZÁR, L. (1961d): The role of the honey bee (*Hym.: Apis mellifera* L.) in relation to lucerne in Hungary. Acta Ent. Mus. Nat. Pragae, **34,** 5—11.

MÓCZÁR, L.—BŐJTÖS, Z. (1957): A lucernát megporzó méhfélék (Bees pollinating lucerne). MTA Agr. Oszt. Közl., **13,** 147—178.

POPOV, V. V.—Попов, Б. Б. (1951): О значении пчел в опылении люцерны. Труды Всесоюзн. Энтомолог. общ., **43,** 65—82.

POPOV, V. V.—Попов, В. В. (1956): Пчелы, их связь с цветковой растительностью и вопрос об опылении люцерны. Энтом. обозр., **35,** 582—598.

PONOMAREVA, A. A. — Пономарева, А. А. (1960): Пчелы — опылители бобовых растений Западного Копет — Даг. Труды Зоол. Инст. Акад. Наук СССР, **27,** 94—166.

STAPEL, C. (1943): Über die Befruchtung der Lucerne durch Insekten in Dänemark. Ent. Medd., **23,** 224—239.

SOLINAS, M.—BIN, F. (1965):Osservazioni sugli insetti impollinatori delle leguminose foraggere Medicago sativa e Trifolium pratense nelle Pianura Padena. Semeni Elette, **11,** 1—32.

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ON THE ASH-COMPONENTS OF LIGNEOUS AND HERBACEOUS PLANTS GROWN ON ACIDIC PRIMARY ROCKS AND ON LAITA-LIME BASE ROCK

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Authors have studied the mineral composition of forest plants originating from two areas not being in far distance from each other. They have established that the analysis of plants grown on sour and — more or less — podsolic soils getting formed on the praeperm gneiss and mica slate base rock of the Sopron mountainous region, indicates mainly to the easy uptake of potassium, phosphor, iron, manganese, zinc and copper. On the other hand, in the rendzina and Ramann-brown soils formed on the Laitaicum lime and sand being of sea origin, it is the calcium and molybdenum content of the plants that indicate the favourable possibilities for the uptake of these elements. Authors mention the considerations to be respected by the game-management of the region. They call the attention to the disadvantageously high Ca/P and to the too low Cu/Mo ratio in the plants of the Laitaicum. Besides, the absolute quantity of manganese and copper does not reach the optimum level required in the fodder of herbivorous animals.

Introduction

In recent years quite a series of publications have been issued in which the more important mineral compositions, including also the microelements, of the wild and cultivated plants grown in this country, have been written about in connection with about 1000 species (TÖLGYESI *et al.* 1962, 1965a, b, c, d, 1966a, b). As a result of investigations the anorganic components have obtained also a certain chemotaxonomic meaning. The phylogenetic connection, the morphological relationship of plants are reflected considerably in the similarity of the composition of the elements. As examples the zinc-accumulation ability of the *Salicaceae* and the regularily high copper content of the *Solanaceae* should be mentioned. These properties are relatively permanent. Viz., on whatever kind of soils, acacia and black pine may be grown near each other, it is always the acacia that contains more copper. Similarly, out of the beech trees and ash trees, on the same soil, it is always the beech that takes up more manganese. These statements do not preclude the possibility for the same species to build in its organism anorganic substances in considerably different quantities when grown at different sites and in different times. The material of this paper has been compiled on the basis of plant-samples gathered from two sites of different characters.

Material and Method

In the environment of Sopron 70 plant samples were collected from two regions having been well marked off concerning both plant geography and pedology.

1. On the praeperm gneiss and mica slate base rock of the Sopron mountainous district there prevail highly acidic non-podsolic, podsolic, pseudo-glaic and brown forest soils with clay washed in them. The area is of subalpine climate, a mountain range of medium height character. Under conditions of 714 mm yearly precipitation having a medium temperature of 8.0—8.5 °C and 80 per cent average relative moisture content, three-levelled, highly eluviated soils got formed. The region belongs to the Ceticum flora district of the Noricum flora-range. The places of occurrence are: Váris, Deákkút, Fáberrét, Tacsi-trench, Daloshegy, Brennberg, Hermesdomb and Asztalfő.

2. The soil of the Laitaicum situated north-northeast from Sopron, consists of Laita-limestone and sand on which there developed, first of all, a two-levelled rendzina and humus carbonate soil as well as a three-levelled Ramann brown forest soil. The provenances are represented by the forests of Szárhalom and Dudlesz. The slightly sloping hilly region has a yearly precipitation of 668 mm; the mean temperature is 9.5—10.0 °C, while the average humidity amounts to 67 per cent. From the point of view of geobotany, it belongs to the Laitaicum flora-district of the Praenoricum flora region.

On the gneiss base-rock the plants have been collected from the following phytocenoses: *Calluno-Genistetum*, *Castaneo-Quercetum*, *Deschampsio-Fagetum luzuletosum*, *Luzulo-Querco-Carpinetum luzuletosum*, *Melitti-Fagetum asperuletosum*, *Melitti-Fagetum caricetosum pilosae*. The phytocenoses of the limestone fundamental rock are: *Cerasetum fruticosae*, *Quercetum petraeae-cerris*, *Quercetum pubescenti-cerris*. On both provenances there occurred the association of *Querco petraeae-Caepinetum*.

The cooler, wetter and more acidic soils of the Sopron mountain-region and, on the other hand, the warmer, drier and more alkaline sites of the Laitaicum have provided contrasted counterparts suitable for the purpose of our investigations.

The plant samples were collected between April 8 and September 9, 1966 while care was taken to bring in the identical plant species gathered at parallel sites, for investigation, within no more than a few days.

A chemical analysis from air-dry plants was performed, after perchloric acid and nitric acid destruction, with flame photometry and colorimetrically as already described, in details, in a previous publication (TÖLGYESI 1966). The result of the analysis referring to 1 kg air-dry plant material, was given in grams in the case of macrosubstances while in that of micro-elements this was done in milligrams.

Results

In Table 1 the plants occurring at both sites, while in Table 2 some characteristic plants of the Sopron mountainous district and the Laitaicum are enumerated. As it could be expected, in the numerical values of the analysis the discrepancy of the two regions that had already been known from other viewpoints had clearly manifested. Regarding some elements this difference is more conspicuous while in respect of others it is less.

The peculiarities of the two sites are even easier to survey in Table 3. With plants gathered parallel, the soils of the primary rocks (gneiss) were favourable for the uptake of potassium, phosphor, manganese, iron, zinc and copper, while the uptake of calcium and of molybdenum was greater in the case of plants grown in soils having been formed on limestone. The quantity of sodium differs but slightly.

The average of characteristic plant species (not taking into account the potassium and sodium content) makes it even clearer that on soils of rendzina

character plants can take up all other elements — except the calcium and molybdenum content, — in smaller quantity than on brown forest soils with acid reaction.

No numerical data can stress better the difference than the milligrams of manganese falling to one gram of calcium being calculated (Table 4). While with the characteristic ligneous plants of the mountainous region this number is 190, in the case of the characteristic ligneous plants of the Laitaicum this is only 2.5. The discrepancy of the manganese/calcium quotient is statistically proved in every case.

On the basis of experiments carried out abroad and in this country, it is well known that the alkaline medium — with the exception of molybdenum, — decreases the uptake-ability of microelements. The manganese is especially responsive to the pH-change. Besides the chemical reaction, the mobility of manganese is conditioned also by the temperature and moisture content. In cold soils saturated with water, manganese is present in bivalent form easy to be taken up, while in the warmer, drier soils being better aired, it occurs with a higher valency in its oxides and hydroxides. Such compounds are taken up by the plant in a more difficult way. Interesting is the formation of the iron/manganese quotient: in the average of each group it is higher on soils with more pH. The least (0.35) Fe/Mn quotient was measured by TÖLGYESI (1965) in the average of the *Fagaceae* family, while the highest value (8.7) was represented by the *Labiatae* family. In our present investigations the least Fe/Mn quotient was found in the average of the ligneous plants of the Sopron mountainous district (0.22), while the highest quotient (3.4) could be evinced in the grassy plants grown on the limestone subsoil.

Reverting to Table 1 we have to establish that concerning zinc content, no considerable differences can be observed in the different species. As to molybdenum content, it is only the *Lathyrus vernus* whose values are outstanding. The species belonging to the *Fabaceae* family and their synbiontae exert nitrogen assimilation activity only with a higher molybdenum concentration than the requirement of other plant species, and even the spring vetch does not seem to be an exception. Quite a different thing is that the Cu/Mo quotient of the vetch grown on rendzina is a figure less than 1, this being an unfavourable property from the viewpoint of foddering.

As regards copper the extreme values are represented in our material of investigation by the *Coniferae* and the leaf of hazel.

Both in different soils and in different species it is the quantity of manganese that changes at the widest range. Among the terrestrial plants the *Abietaceae, Betulaceae, Fagaceae* families are outstanding in manganese content; only the aquatic plants surpass these latter ones (KÁRPÁTI *et al.* 1967). In our material of investigation the *Fabaceae, Labiatae, Rubiaceae, Liliaceae* families belong to the plants having less manganese content. We should like to mention,

Table 1

Mineral composition of plants

Name of the plants	K		Ca		P	
	g/kg					
	H.	Sz.	H.	Sz.	H.	Sz.
H + Sz. gathered parallel						
Ligneous plants						
Carpinus betulus L. leaf	18.4	23.2	10.6	8.4	2.6	4.5
Cerasus avium (L.) Moench, leaf	25.1	23.3	7.1	8.4	5.7	4.5
Cerasus avium (L.) Moench, twig	6.9	5.7	9.0	15.3	0.65	0.59
Corylus avellana L. leaf	19.2	17.8	4.2	6.9	5.3	4.7
Fagus silvatica L. bark from branch	—	3.2	—	27.5	—	0.35
Fagus silvatica L. bark from stem	3.6	2.8	15.7	25.5	0.53	0.46
Fagus silvatica L. leaf	34.3	16.7	2.5	2.5	4.1	3.8
cult. *Picea, Abies* (L.) Karst. needle	10.2	10.7	2.2	2.6	1.5	1.5
cult. *Picea, Abies* (L.) Karst. twig	9.3	10.8	1.1	2.3	0.84	1.6
cult. *Picea, Abies* (L.) Karst. leaf	9.4	5.9	3.3	4.8	1.9	0.6
cult. *Picea, Abies* (L.) Karst. twig	8.7	5.0	2.0	3.2	1.3	0.8
cult. *Pinus nigra* Arn. leaf	7.5	5.7	3.9	3.3	1.0	2.9
cult. *Pinus nigra* Arn. twig	5.6	2.3	2.5	7.8	0.7	0.3
cult. *Pinus silvestris* L. leaf	5.1	4.3	4.7	4.5	1.0	0.6
cult. *Pinus silvestris* L. Joung needle	10.2	—	1.7	—	2.4	—
cult. *Pinus silvestris* L. twig	5.0	3.3	3.6	3.6	0.7	0.4
Grassy plants						
Asperula odorata L.	42.5	32.3	16.8	18.7	3.4	1.48
Calamintha clinopodium Spenner	20.3	22.0	8.2	8.2	2.2	1.7
Centaurium minus Mönch	14.7	12.0	1.4	2.0	2.2	1.2
Convallaria majalis L.	55.0	27.9	5.4	10.4	7.0	9.2
Galium verum L.	13.2	12.1	6.0	8.8	1.8	1.2
Hypericum perforatum L.	11.1	8.2	3.7	2.8	3.4	1.3
Lathyrus vernus (L.) Bernh.	25.3	29.0	14.4	8.2	2.2	2.6
Melica uniflora Retz.	24.6	16.3	1.9	4.2	2.0	0.8
Melittis grandiflora Scholler	38.0	29.7	6.1	10.9	3.2	1.4
Stellaria holostea L.	24.0	34.0	4.9	7.7	3.0	1.4

H = Mountainous district: gneiss fundamental rock

gathered from both soils

Na		Fe		Mn		Zn		Cu		Mo	
g/kg		mg/kg									
H.	Sz.	H.	Sz.	H.	Sz.	H.	Sz.	H.	Sz.	H.	Sz.
0.37	0.25	230	216	2920	68	35	17	14.3	11.8	0.07	0.25
0.22	0.25	255	216	365	68	19	17	15.6	11.8	0.33	0.25
0.27	0.34	89	115	220	83	13	18	6.5	5.7	0.36	0.24
0.17	0.22	234	214	3050	228	32	18	21.0	16.6	0.50	0.91
—	0.57	—	147	—	73	—	12	—	3.7	—	0.36
0.39	0.51	175	233	1600	120	14	6	5.3	5.6	0.04	0.25
0.22	0.13	123	122	1490	65	31	29	15.4	24.6	0.01	—
0.12	0.12	147	122	925	365	23	24	3.1	3.8	0.20	0.41
0.13	0.08	297	274	485	218	49	34	7.8	12.6	0.29	0.43
0.17	0.20	121	110	900	320	31	19	5.2	1.9	—	0.10
0.18	0.18	205	296	340	197	38	39	5.9	3.6	0.54	0.17
0.20	0.18	132	204	815	30	20	19	3.2	2.8	0.14	0.23
0.29	0.27	199	270	174	48	21	24	5.9	3.6	0.11	0.15
0.31	0.22	345	123	890	29	45	25	4.4	2.6	0.15	0.22
0.25	—	166	—	426	—	49	—	6.9	—	—	—
0.23	0.14	434	280	290	10	35	31	5.4	5.5	—	0.20
0.48	0.42	290	168	186	54	54	27	5.3	4.4	0.43	0.48
0.28	0.22	1130	320	78	103	21	24	3.2	4.6	1.2	0.49
0.11	0.12	660	340	118	44	37	41	6.3	9.5	0.73	0.23
0.24	0.32	257	131	68	36	33	31	12.0	10.5	0.17	0.04
0.20	0.24	210	315	210	45	86	33	4.8	5.9	0.38	1.0
0.19	0.11	560	82	215	23	19	16	9.5	6.1	0.89	0.50
0.34	0.27	97	226	58	58	9	19	5.3	6.5	1.2	9.5 !!
0.14	0.14	435	143	405	205	52	15	7.8	4.6	0.31	0.20
0.35	0.35	296	210	740	47	46	51	6.7	9.8	—	—
0.26	0.40	144	223	1650	815	49	39	3.4	4.4	0.15	—

Sz = Szárhalom-forest: Laita-lime

Table 2

Mineral composition of plants characteristic of (A) gneiss

Name of the plant	K	Ca	P
	g/kg		
A. Plants gathered only from the mountainous district (also characteristics of it):			
Ligneous plants:			
cult. *Abies alba* Mill., leaf	7.4	8.5	1.4
cult. *Abies alba* Mill., twig	4.3	2.1	0.5
cult. *Abies alba* Mill., leaf	5.0	16.5	0.9
cult. *Abies alba* Mill., twig	3.8	5.1	0.5
Castanea sativa Mill.	13.6	4.7	2.3
cult. *Larix decidua* Mill., leaf	8.3	3.3	2.1
cult. *Larix decidua* Mill., twig	5.0	4.4	1.9
cult. *Larix decidua* Mill., leaf	14.5	2.5	4.2
cult. *Larix decidua* Mill., twig	5.6	5.0	0.9
Salix caprea L.	20.7	3.8	5.2
Tilia cordata Mill.	30.1	2.2	3.0
Herbaceous plants:			
Carex pilosa Scop.	25.0	2.5	1.5
Hieracium silvaticum (L.) Grufb.	10.5	6.2	2.6
Luzula albida (Hoffm.)	17.0	3.9	1.2
Vaccinum myrtillus L.	9.5	7.0	1.3
B. Plants gathered only from the Szárhalom-forest (and also characteristic of it):			
Ligneous plants:			
Cerasus fructicosa Jacq.	10.2	18.2	0.9
Quercus pubescens Willd.	10.9	9.0	1.4
Rhamus saxatilis Jacq.	14.5	28.1	1.0
Herbaceous plants:			
Buphthalmum salicifolium L.	34.7	11.0	1.2
Knautia drymeia Heuff.	27.0	13.7	0.9

Soil types: 1 = brown forest soil with clay washed in
2 = highly acidic brown forest soil
3 = podsolic brown forest soil

basis rock and of (B) limestone basic rock

Na	Fe	Mn	Zn	Cu	Mo	Soil type
g/kg	mg/kg					
0.30	217	1840	37	5.6	0.42	1
0.17	149	370	26	4.5	0.11	1
0.45	367	2900	21	2.3	—	1
0.23	865	735	20	5.0	—	1
0.24	185	1040	28	6.9	0.12	2
0.18	205	1230	31	6.7	0.15	1
0.25	650	850	33	7.3	0.23	1
0.17	230	870	30	10.0	0.23	1
0.27	455	715	41	6.7	0.28	1
0.18	97	97	51	9.9	0.01	2
0.20	142	374	33	12.2	0.01	1
6.25	163	226	—	7.4	0.22	1
0.30	173	198	—	8.0	0.25	3
0.16	330	1160	25	4.8	0.55	3
0.30	97	805	27	3.8	0.17	2
0.58	35	21	51	3.8	0.11	4
0.39	50	94	11	5.7	0.07	5
0.70	97	22	13	2.5	—	5
0.40	76	51	42	5.9	0.39	4
0.45	205	33	45	4.4	—	6

4 = earthy skeleton soil
5 = black rendzina
6 = Ramann-brown forest soil

Table 3

Group-means in the analyses of

		Ca/P		K	Ca	P
				g/kg		
Ligneous,	Hv.	2.25	I.	11.9	4.9	2.0
Ligneous,	Sz.	4.67		9.4	8.4	1.8
Herbaceous,	Hv.	2.3		26.9	6.9	3.0
Herbaceous,	Sz.	3.72		22.4	8.2	2.2
Ligneous,	Hv.	2.52	II.	10.8	5.3	2.1
Herbaceous,	Hv.	2.88		15.5	4.9	1.7
Ligneous,	Sz.	16.6	III.	11.9	18.3	1.1
Herbaceous,	Sz.	11.3		30.9	12.4	1.1

In group I plants are shown that had been gathered parallel from the mountainous district and the Laiticum

In group II average of the plants characteristic of some mountainous districts

In group III some averages of plants characteristic of the Laitaicum

Hv. = mountainous district: acidic, podsolic, pseudogleic grown forest soils with clay washed in

Sz. = Szárhalom: humus carbonate and rendzina, Ramann-forest soils

briefly, some aspects of the game forage, too. In the case of herbivora the value of the Ca/P ratio is being established around 2. The ligneous and herbaceous plants grown on rendzina soils have a calcium surplus that exerts unfavourable effect. In the same way, some plant species grown on the Laitaicum area might also be considered objectionable being their manganese content 80, while the copper content is under 5 mg per kilogram.

In game-husbandry the microelement content of ligneous and soft-stemmed plants coming from different sites, might also be of greater importance, as the different kinds of deer *(Cervidae)* are bound in their feed and also in their other manifestation of life, to ligneous flora, i.e. to the woods. Therefore, it is by no means indifferent how the feed available in the environment of the game could cover its special requirements. Thus, e.g. for building up the stag's bone-system and the yearly changing antlers being sometimes of considerable weight (10—12 kg), for nourishing the embryo, etc., continuous and, sometimes even increased quantities of mineral materials are needed. If in the most critical period of the deer's life: in winter and in spring certain mineral substances are missing or if they are available in a disadvantageous ratio, one cannot reckon with the development of a good bone-system, with the formation of suitable antlers required for shooting purposes; moreover, there might occur

plants gathered in Sopron

Na	Fe	Mn	Zn	Cu	Mo	Fe/Mn
g/kg	mg/kg					
0.23	210	993	30	8.4	0.23	0.22
0.24	196	128	22	7.7	0.29	1.5
0.26	408	373	41	6.4	0.60	1.1
0.26	216	143	30	6.6	1.6	1.5
0.24	323	1002	33	7.0	0.17	0.32
1.8	191	597	26	6.0	0.29	0.32
0.57	60	46	25	4.0	0.9	1.3
0.42	141	42	43	5.2	0.39	3.4

Statistical test (Student t-test) of the differences (d) in the average Ca and Mn content of group I.

Plant-group	Ca			Mn		
	d	found	scheduled	d	found	scheduled
Ligneous plants	3.5	$t = 3.27$	$t_{P1\%} = 3.01$	865	$t = 2.13$	$t_{P5\%} = 2.16$
Herbaceous plants	1,3	$t = 1,16$	$t_{P10\%} = 1.83$	250	$t = 1.93$	$t_{P10\%} = 1.83$

irregularities in rutting and conception, too. At the same time woodpeeling, which can generally be attributed to some deficiency might have deleterious effects on forest management, too.

The composition of the plants grown in the Sopron mountainous district and in the Laitaicum considerably differ from one another in such important indices as the Ca/P, the Fe/Mn ratio or the copper content being so important for keeping game; then complementary foraging (fodders, salt-providing places) have to be made up in a way that the absolute quantity of the elements and their ratio should equally be ensured. These will be of increasing importance in the regional game management swinging up just in our days.

Our experiments have confirmed, under well-defined circumstances, the previously obtained experiences on the uptake ability of certain elements. With a semi-quantitative spectrographic method (LOUNAMAA 1956) less B-, Mn-, Co- and Ni have been evinced in wild plants grown on limestone than in species grown on acidic rocks. In the same manner, concerning the manganese content of lucerne, as values, 31 ppm have been obtained on granite, and 25 ppm on limestone (ANKE 1962). In meadow-hays of different botanical composition, on an inundation soil containing 32 per cent $CaCO_3$, 135 ppm manganese had

Table 4

The formation of the manganese/calcium ratio in ligneous plants grown on gneiss and limestone basic rocks

$$\frac{Mn}{Ca} \cdot 1000$$

The plant and its part examined	On gneiss	On limestone
Carpinus betulus — blue beech, leaf	284.0	8.1
Cerasus avium — bird-cherry, leaf	47.4	8.1
Cerasus avium — bird-cherry, twig	24.5	5.4
Corylus avellana — hazel, leaf	227.0	29.7
Fagus silvatica — beech, bark	112.0	2.6
Fagus silvatica — beech, leaf	596.0	26.0
Picea, Abies — spruce, pine-needle	420.0	140.0
Picea, Abies — spruce, twig	440.0	95.0
Picea, Abies — spruce, pine-needle	273.0	67.0
Picea, Abies — spruce, twig	170.0	62.0
Pinus nigra — black pine, pine needle	209.0	9.1
Pinus nigra — black pine, twig	70.0	6.2
Pinus silvestris — Scotch fir, pine-needle	189.0	6.5
Pinus silvestris — Scotch fir, twig	88.0	2.8

The statistical test of the difference of the manganese/calcium-quotient as measured at two sites: $t = 3.1 \quad t_{P1\%} = 3.01$

been measured on lime-free pseudogleic soil (BOLZER *et al.* 1962). Austrian researchers (SCHILLER *et al.* 1967) have measured the most manganese, all over Austria, in grassy fodder-plants, in the region of Mühlviertel, on brown forest soils developed on granite and gneiss. Our investigation have submitted data — from a new point of view — both on the previously known (e.g. 11) pH-dependance of manganese uptake and also on the Ca-Mn-antagonism (HALL *et al.* 1964, LOUNAMAA 1956).

Conclusions

It can be established that the differences revealing themselves in the calcium content and pH of the soil, exert a decisive influence on the uptake-capacity of microelements. On more acidic soil it is primarily the manganese, but even iron, zinc and copper that can be better taken up for the plants, while the mobility of molybdenum is less on that type of soil. On soils saturated with lime, the uptake of the above microelements is just the opposite, i.e. these types of soils are favourable for the molybdenum uptake. These phenomena

give an explanation to the limited spreading of more than one stenotope species. The fir requires more manganese than the black pine and that quantity is to be found only on sour, more or less podsolic soil occurring in a movable form. Similar is the behaviour of the *Luzula albida* and of the huckleberry *(Vaccinium myrtillus)*, too. These plants are, of course, also soil-indicators. On the other hand, plants being more flexible, like e.g. the black pine *(Pinus nigra)* might be an excellent model material for the quantitative determination on the movable microelement of the soil. Thus, on the two soil-types within the region examined by us, 815 and 31 ppm (mg/kg) manganese concentration is evinced showing a 27-fold difference. Most probably, on other kinds of soils it takes up all values between the above two limits, so it might be suitable for the numerical examination of the manganese content that can be taken up by the plant. In soil science, the extraction processes actually used for the determination of "mobil" manganese do not always give parallel results with the manganese content of the plants.

REFERENCES

ANKE, M.—SASUM, K.—OLL, Ü.—GRAUPE, B. (1962): Die Zusammensetzung der Luzerne-Böden verschiedener geologischer Herkunft. Archiv. f. Tierernährung., **12,** 93—108.

BALZER, I.—CALETA, Z.—POZEZANAC, T. (1962): The content of biogenic trace elements in the grasses of Lonjsko Polje. Archiv za poljoprivredne nauke., **15,** 117—124.

HALL, J. W.—AALDERS, L. E.—TOWSEND, L. R. (1964): The effects of soil pH on the mineral composition and growth of the Lowbush Blueberry. Can. J. Plant Sci., **44,** 433—438.

HARASZTI, E.—TÖLGYESI, GY. (1961): A savanyúfüvek ásványianyag-tartalma (The mineral content of sour grasses). Magyar Állatorvosok Lapja, **16,** 177—180.

HARASZTI, E.—TÖLGYESI, GY. (1961): Die Bedeutung des Mineralstoffgehaltes der Sauergräser für die Fütterung. Acta Veterinaria Acad. Sci. Hung., **11,** 393—399.

HARASZTI, E.—TÖLGYESI, GY. (1962): Hazai pázsitfüvek molibdéntartalma (Molybdenum content in grasses in this country). Magyar Állatorvosok Lapja, **17,** 417—419.

HARASZTI, E.—TÖLGYESI, GY. (1963): Der Molybdengehalt der einheimischen Süßgräser. Acta Veterinaria Acad. Sci. Hung., **13,** 141—145.

KÁRPÁTI, I.—KÁRPÁTI, V.—TÖLGYESI, GY. (1967): Manganese content of aquatic plants. Acta Botanica Acad. Sci. Hung., **13,** 96—112.

LOUNAMAA, J. (1956): Trace elements in plants growing wild on different rocks in Finland. Ann. Bot. Soc. Vanamo., **29,** 1—196.

MODOR, V.—TÖLGYESI, GY. (1964): Adatok a szikes réteken és legelőkön termő növények makro- és mikroelem-tartalmáról (Data on the macro- and microelement content of plants growing on alkali meadows and pastures). Kísérleti Közlemények, **17/B,** 59—66.

PAGE, E. R. (1962): The relationship of soil pH to manganese availability. Plant and Soil, **16,** 247—257.

SCHILLER, H.—LENGAUER, E.—GUSENLEITNER, J.—HOFER, B. (1967): Fruchtbarkeitsstörungen bei Rindern im Zusammenhang mit Düngung, Flora und Mineralstoffgehalt des Wiesenfutters. Veröffentlichungen der Landwirtschaftlich-chemischen Bundesversuchsanstalt Linz. 1—136.

TÖLGYESI, GY. (1962): Vadontermő növények mikroelem-tartalma (Microelement content of wild plants). Agrokémia és Talajtan, **11,** 203—208.

TÖLGYESI, GY. (1965): Adatok az erdei fák és cserjék Ca-, P-, Fe-, Mn-, Zn- és Cu-tartalmáról (Data on the Ca-, P-, Fe-, Mn-, Zn- and Cu-content of forestrial trees and shrubs). Az Erdő, **14,** 275—281.

TÖLGYESI GY. (1965a): Vízinövények ásványi anyagai és tógazdasági jelentőségük (The mineral contents of aquatic plants and their importance in fisheries). Halászat, **11/58,** 111.

TÖLGYESI, GY. (1965b): Applicability of newest knowledge on the microelement content of plants in different fields of agricultural sciences. Acta Agronomica Acad. Sci. Hung., **13,** 181—190.

TÖLGYESI, GY. (1965c): Tájékoztató adatok néhány gyógynövény ásványianyag-tartalmáról (Informatory data on the mineral content of some medicinal plants). Herba Hungarica, **4,** 181—190.

TÖLGYESI, GY. (1966): Gyomnövények mikroelem-tartalma (The microelement content of weeds). Magyar Állatorvosok Lapja, **12,** 446—449.

TÖLGYESI, GY. (1966a): A szálastakarmányok mikroelem-tartalma (Microelement content of rough fodder). Kandidátusi értekezés, Budapest.

VOSE, P. B.—JONES, D. C. (1963): The interaction of manganese and calcium on nodulation and growth in varieties of *Trifolium repens*. Plant and Soil, **18,** 372—385.

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COMPLEX EFFECT OF IRRIGATION, GREEN MANURING AND HIGH RATE FERTILIZATION IN VINEYARDS ON SAND SOILS

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The complex effect of irrigation, green manuring and high rate fertilization has been studied in vineyards on sand soils. Results of the two years investigation (1965—1966) showed that irrigation (I) and fertilization (F) had — even separately — induced a statistically proved positive effect on the volume of the yield. In case of a combined treatment (I + F) this effect — though not significant — showed an increasing tendency. On the other hand, green manuring resulted in a considerable yield surplus only when applied with the combined treatment of irrigation and fertilization (I + F + G), or combined with fertilization (F + G), but when given alone (G), or with irrigation only (I + G), the amount of yield hardly differed from that of the control. Thus, green manuring is reasonable and has to be carried out only when completed with fertilizers. As to the quality of the yield it was only improved by the irrigation and treatments connected with it. This slight improvement can be best seen — and is as well significant — especially in the g/cad. hold results of the sugar content (Table 4).

Introduction

According to Liebig's law "the yields of plants always follow the trend of production factors available in the smallest quantities". This means that all factors promoting an increase in the quantity and quality of yield have to be taken into consideration and studied in their interactions and correlations rather than separately. As for the two main life factors — nutrients and water — the lack of the latter offers frequent problems in our vineyards on sand soils of the Great Plain. Neither the effect of green manuring replacing the farmyard manure in wide spaced, high trained vineyards, nor that of the high rate mixed fertilization providing for the nutrient supply of larger growing surfaces have been made clear so far.

Although vine does not require too much water, excessive dryness results in a considerable decrease both in quantity and quality of the yield. Therefore, irrigation of vines in regions poor in precipitation may be important from a national economic point of view as well — especially in periods of drought. Thus, introduction of irrigation, prior to intensifying production, is justified primarily by our climatic conditions. While studying the precipitation data of 65 years (1901—1965) at Kecskemét, FÜRI—KOZMA (1967) found that

18.5 per cent of the years was too dry, often droughty; 20.0 per cent dry, 32.4 per cent was of average precipitation, 23.0 per cent wet and 6.1 per cent very wet.

Apart from the yield increasing effect of irrigation, some authors (BUDIG 1960, FÜRI 1964, KONLECHNER 1958, MANARESI 1947, REVUNOVA 1954, WANKE 1954, 1955) report on its beneficial influence on the quality of wine and table grapes. According to SZEGEDI's investigations (1963) varieties of intensive root-type (e.g. Irsai Olivér) had better be irrigated; this opinion is supported by GEISLER (1957) who suggests that varieties of intensive root-type endure drought to a lesser extent.

In order to find new ways of supplying vines with organic matter, our Institute has been for several years studying the effect of green manuring on organic matter production and humus increase respectively. Plants used as green manure absorb, however, large quantities of water from the soil, thus depriving vines of the necessary moisture content. Therefore, in vineyards planted on sand soils, under non-irrigated conditions only winter plants (mixture of ryes and wetches, rape) should be sown, and worked into the soil before the water demand of vines appears in spring — i.e. prior to the total development of the green lot. On the other hand, green manure plants sown in spring should be grown only under irrigated conditions. Green manure decomposes in the soil at a much higher rate than farmyard manure, therefore — according to NIZSALOVSZKY (1962) — in loose soils the highest effect can be observed in the first year following working in, while in the third year hardly any effect can be seen. According to MARES' results (1961) green manuring — in addition to improving the producing capacity of the soil — does increase its water capacity as well as the efficiency of winter precipitation.

For its yearly total yield (clusters and shoots) the vine uses up a considerable amount of the nutrient content of the soil. Irrigation, however, goes on increasing the nutrient requirement of vines by causing a yield surplus on one hand, and washing away the nutrients on the other; that is why an abundant nutrient supply is considered to be one of the basic factors of successful irrigation. The higher nutrient supply required by irrigation was well demonstrated in PFAFF's (1960) experiments performed in 1 m deep concrete lysimeters. According to KOZMA (1966) nitrogen fertilizer doses of regularly irrigated vineyards should be increased at least by 100—150 per cent, while potassium and phosphorus fertilizers by 60—80 per cent. Further, with easily soluble fertilizers (nitrogen) applied, he recommends differentiated fertilization. BRANAS *et al.* (1946) also found nutrients washed out in soils permeable to water to a relatively higher extent, especially in case of high rate irrigation.

Material and Method

Research work was started in the autumn of 1964 at the Katonatelep farm unit of the Institute, with an own-rooted table-grape vineyard just beginning to bear (4 years old). The years of the examinations were 1965 and 1966, whose monthly data of temperature, precipitation and sunshine hours are included in Table 1. In accordance with the up-to-date requirements of large-scale vineyards vines are spaced at a distance of 320×70 cm, where possibilities of growing plants for green manuring between the rows are provided for. The experimental area is 2 cad. hold 98 square öl (1.5 ha approximately). The variety grown is "Irsai Olivér", a table-grape vine of double utilization. The area is located mostly on level ground of uneven surface here and there; on the basis of several (6) sample pits dug into the soil show the following layers:

Table 1

Major meteorological data of the years of investigation

Months	Temperature (°C)			Precipitation (mm)			Sunshine hours (hour)		
	1965		50 years average	1965	1966	50 years average	1965	1966	50 years average
I	0.0	−3.9	−1.7	45	47	27	40	37	61
II	−2.2	6.5	0.0	4	16	30	119	90	82
III	6.0	5.9	5.7	29	60	34	178	157	134
IV	9.6	13.6	11.1	58	46	48	158	198	186
V	14.5	17.3	16.9	76	69	58	220	294	258
VI	19.4	20.3	20.0	130	46	57	259	265	271
VII	20.9	21.4	22.1	90	79	51	320	289	304
VIII	18.8	20.8	21.1	49	48	47	293	304	274
IX	17.2	16.8	16.7	25	18	50	245	236	197
X	10.0	15.5	10.9	0	34	49	240	171	139
XI	2.9	5.2	4.8	134	97	52	49	49	73
XII	2.2	1.6	0.6	66	54	39	37	55	45
		mean			total			total	
	9.9	11.7	10.7	706	614	542	2158	2145	2024

0—125 cm sand
125—165 cm clay-sand
165—200 cm sandy clay

Results of laboratory soil tests are shown in Table 2.

The experiment was arranged in random blocks, with 100 vines per plot, in four replications, with two factors in the following combinations:

A = *Water supply*
- a_1 = dry
- a_2 = irrigated

B = *Method of supplying nutrients*
- b_1 = unfertilized
- b_2 = fertilized
- b_3 = green manured
- b_4 = fertilized and green manured

Table 2

Major agrochemical properties of the soil on the experimental area

Depth of sampling	$CaCO_3$	Humus	Total N	Available	
				PO_2O_5	K_2O
cm	%	%	%	mg/100 g soil	
1	2	3	4	5	6
0—30	2.64	0.58	0.07	18.59	12.26
30—60	2.43	0.61	0.06	17.04	6.83

Method: 2) With Scheibler's instrument
3) With potassium permanganate technique
4) According to Jodlbauer
5) Egner's method
6) Kühn's method

Treatments	*Index of treatment*	*Combination*
1. Untreated (control)	∅	a_1 b_1
2. Irrigated	I	a_2 b_1
3. Fertilized	F	a_1 b_2
4. Irrigated and fertilized	IF	a_2 b_2
5. Green manured	G	a_1 b_3
6. Irrigated, green manured and fertilized	IFG	a_2 b_4
7. Irrigated and green manured	IG	a_2 b_3
8. Fertilized and green manured	FG	a_1 b_4

The irrigation was sprinkling-like, carried out by using perforated pipes. It took place when the moisture content of the soil began to sink below 70 per cent of the water capacity in the field. When irrigation was to replace rainfall, 50 l/m² water (net) was used in every case, with losses from evaporation (air, soil) deducted. Irrigation water was provided for by the third water-layer under the soil surface, through a 32 m deep driven well.

Yearly application in details	Ammonium nitrate N 34%	Super-phosphate P_2O_5 18.5%	Potassium chloride K_2O 40%	Total
	q/cad. hold			
Before autumn sowing	2.0	6.0	7.0	15.0
Top dressing to winter plants	1.0	—	—	1.0
Worked in with winter plants	2.0	—	—	2.0
Worked in with spring plants	2.0	—	—	2.0
Gross total	7.0	6.0	7.0	20.0
Total active agents	2.4	1.1	2.8	6.3
Yearly proportions of fertilizers in %	37.9	17.6	44.5	100.0

Table 3

Effect of irrigation, green manuring, fertilization as well as of their combinations on the berry weight, sugar- and acid content, at the beginning of ripening and in the time of consumability

On the average of two years (1965—1966)

Indexes of			Berry weight	Sugar	Acid
Treatments	Combinations		g	M. m grade	‰
			A) *At the beginning of ripening (1. August)*		
∅	a_1 b_1		1.15	9.7	15.4
I	a_2 b_1		1.25	9.9	16.1
F	a_1 b_2		1.20	9.7	15.2
IF	a_2 b_2		1.25	9.8	15.3
G	a_1 b_3		1.20	10.0	15.1
IFG	a_2 b_4		1.25	9.7	15.7
IG	a_2 b_3		1.27	10.3	15.9
FG	a_1 b_4		1.24	10.0	14.3
Effect of irrigation (A)		F	3.50	0.0	4.7*
		$S.D._{5\%}$	—	—	0.7
Effect of nutrients (B)		F	0.58	1.0	0.9
		$S.D._{5\%}$	—	—	—
Interaction (A × B)		F	0.08	0.7	0.6
		$S.D._{5\%}$	—	—	—
			B) *In the time of consumability (26. August)*		
∅	a_1 b_1		2.16	15.8	4.7
I	a_2 b_1		2.12	15.9	4.8
F	a_1 b_2		2.15	15.4	5.2
IF	a_2 b_2		2.10	15.7	4.9
G	a_1 b_3		2.12	16.1	5.3
IFG	a_2 b_4		2.11	15.8	5.4
IG	a_2 b_3		2.17	16.3	4.7
FG	a_1 b_4		2.08	15.6	4.9
Effect of irrigation (A)		F	0.00	1.5	0.2
		$S.D._{5\%}$	—	—	—
Effect of nutrients (B)		F	0.00	2.4	0.5
		$S.D._{5\%}$	—	—	—
Interaction (A × B)		F	3.33*	0.2	4.0*
		$S.D._{5\%}$	0.19	—	0.6

Table 4

The effect of combinations of irrigation, green manuring and fertilization on the fruit weight, sugar- and acid content and on the trend of the sugar yield in the time of harvest

On the average of two years (1965—1966)

Indexes of		Fruit q/cad. hold	Suga	Acid ‰	Sugar yield q/cad. hold
Treatments	Combinations				
∅	a_1 b_1	25.9	16.8	7.7	3.11
I	a_2 b_1	33.2	16.9	7.9	3.96
F	a_1 b_2	34.7	16.3	7.6	4.02
IF	a_2 b_2	35.2	16.9	7.9	4.24
G	a_1 b_3	28.1	16.7	7.8	3.56
IFG	a_2 b_1	36.8	16.8	7.6	4.90
IG	a_2 b_3	28.2	16.9	7.7	3.45
FG	a_1 b_4	31.3	16.4	7.8	3.42
Effect of irrigation (A)					
	F	4.5*	3.2*	0.0	4.7*
	S.D. 5%	3.2	0.1	—	0.6
Effect of nutrients (B)					
	F	4.5*	0.7	0.4	1.7
	S.D. 5%	4.6	—	—	—
Interactio n (A × B)	F	1.3	0.3	1.4	1.7
	S. D. 5%	—	—	—	—

Plants for green manuring were sown twice a year: in autumn and in spring. Winter plants (50 kg/cad. hold rye + 50 kg/cad. hold hairy vetch) were sown at the end of August, while spring plants (30 kg/cad. hold oats + 70 kg/cad. hold spring vetch) at the end of April — immediately after the green lot of winter plants had been worked in. Green manure plants sown in spring were worked in at the end of July.

In high rate fertilization 20 q/cad. hold mixed fertilizer was distributed a year and worked in with MR-type rotary hoes or disc harrows. Quantity and percentage expressed in gross and net active agent of fertilizers used in both years of the experiment were as follows:

The loading of vines was carried out in each plot on the basis of the same principle — the condition of vines — by leaving 9—11 buds per m^2.

When fruits began to ripen, as well as at the stage of full ripeness, fruit samples were taken in order to elucidate the changes in fruit weight, sugar- and acid content. Average weights were established, then, after squashing the fruits, the sugar content was determined with a refractometer and the acid content with 10/n alkali (Table 3).

Positive and negative effects of treatments on the quantity and quality of the yield were determined by examinations carried out at harvest. The harvested clusters were weighed by plots and treatments — total weight was projected to q/cad. hold —, the sugar- and acid content of fruits was determined by must-grading and titration respectively. Data averaged by treatments are presented in Table 4.

Results

The results of investigations carried on for two years are shown in the average of the years. To prove the individual effects and interactions of the factors we have performed — by using Fisher's variance analysis — also significance calculations (SVÁB 1967). The data are presented in the Tables.

On the basis of results obtained and evaluated in the course of the years of investigation the following facts were established:

Both years were of average temperature but rainier and much richer in sunshine hours than the 50 years average. Still the effect of irrigation carried out in dry periods (of 10—14 days) in order to replace rainfall was significant (concerning the amount of yield and the sugar content) at several places (Table 4). Although nutrition had a positive effect on the per cad. hold sugar content, significant yield surplus was found only in treatments combined with fertilization.

As for the quantity and quality of the yield no significant interaction was proved between the two factors (irrigation and nutrition).

When comparing — in the average of the period of investigation — the q/cad. hold data of sugar yield representing both the quantity and quality of grapes produced we can see that the highest sugar yield was resulted by irrigation combined with organic and unorganic nutrition (IFG). The second best combination was irrigation and fertilization (IF) and the average data of plots treated with only irrigation (I) or fertilization (F) respectively are approximately as good.

Irrigation as well as green manuring and fertilization applied to table grapes during the period of ripening showed some positive effect on the fruit weight at the beginning of ripening. This difference, however, is not significant and later it decreases considerably and by the time of full ripeness the fruit weight is about the same in all treatments.

As for the sugar content, significant differences between treatments were not observed either in the course of ripening or when examining the must filtered from the harvested fruits.

Conclusions

From the results of investigations as concerns the effects of factors involved in the experiment, the following conclusions can be drawn:

Irrigation of vineyards on sand soils poor in water is justified primarily in dry, droughty years, but may be necessary when dry periods occur during the growth season. Irrigation has, even in the latter case, a positive effect on the amount of yield (+7.3 q/cad. hold) but causes no major differences either in the development and ripening of fruits or in the quality (sugar and acid content) of fruit and must.

Within the nutrient supply factor, fertilization, in itself, also resulted in a statistically proved yield surplus similar to those caused by irrigation (+8.8 q/cad. hold), while the results of green manuring hardly differed (+2.2 q/cad. hold) from those of the control. In plots with a combined treatment of green manuring and fertilization sugar grades of the must are lower by 0.2—0.6; these results are, however, not significant.

When examining the interaction of the two factors (water and nutrients) we find it to be of a positive tendency — even if not always significant. This statement is best proved by the data of fruit weight and sugar content. Here, the two factors of our experiment gave similar surpluses, while their combined action resulted in an even higher effect. This is due simply to the fact that the nutrients are better recovered by the plants under the influence of irrigation water. We have to mention, however, that within the combinations of individual factors only irrigation or fertilization were found to have a positive effect in any case, while the effect of green manuring within the combinations was rather negative.

REFERENCES

Branas, J.—Bernon, G.—Levadoux, L. (1946): Éléments de la viticulture générale. Montpellier.

Budig, H. (1960): Auswirkung einer Weinbergsberegnung auf die Reifeentwicklung der Reben im extremen Trockenjahr 1959. Der Deutsche Weinbau, **23,** 959—960.

Füri, J. (1964): A szőlő öntözésének tavalyi tapasztalatai (Results of vineyard irrigation in the last year). Kertészet és Szőlészet, **11,** 14—16.

Füri, J.—Kozma, F. (1967): Vizsgálatok az öntözésnek a szőlő állományklímájára gyakorolt hatásáról (Studies on the effect of irrigation on the climate of vineyards). Öntözéses gazdálkodás, **5,** 87—100.

Geisler, G. (1957): Untersuchungen zum Verhalten interspezifischer Vitis- Kreuzungen gegen Trockenheit. Vitis, **2,** 82—91.

Konlechner, H. (1958): Veinberg-Beregnungsversuche 1957. Mitt. Ser. A. Rebe u. Wein, **2,** 120—126.

Kozma, P. (1966): Szőlőtermesztés 2. (Vine growing 2.) Mezőgazdasági Kiadó, Budapest, 417—456, 476—496.

Manaresi, A. (1947): Trettato di viticoltura. Edizione Agricole, Bologna.

Mares, L. (1961): Zelené Hnojeni. Praha. 326.

Nizsalovszky, J. (1962): Kérdések és feleletek a korszerű trágyázás gyakorlatából (Questions and answers of up-to-date nutrition). Mezőgazdasági Kiadó, Budapest, 32—33.

Pfaff, O. (1960): Nährstoffauswaschungen aus dem Boden bei Anbau von Reben. Weinberg und Keller, Frankfurt/M., **7,** 225—229.

Revunova, O. A.—Konkova, R. D.—Ревунова, О. А.—Конкова, Р. Д. (1954): Опыт орошения виноградников. Сад и Огород, Москва, **5,** 73—75.

Sváb, J. (1967): Biometriai módszerek a mezőgazdasági kutatásban (Biometric methods in agricultural research work). Mezőgazdasági Kiadó, Budapest, 152—156.

Szegedi, S. (1963): Néhány csemegeszőlő fajta gyökérrendszerének vizsgálata (Examination of the root system of some table grapes). Szőlészeti Kutató Intézet Évkönyve, **12,** 133—153.

Stoev, K. D.—Magriso, Ju. V.—Стоев, К. Д.—Магрисо, Ю. В. (1957): Влияние на вегетационните поливки върху хода на Физиологическите процеси и добив ността на лозата. Научны Трудове 1. София, Земиздат.

Wanke, K. G. (1954): Bessere Reife und höhere Qualität durch künstliche Beregnung. Der Winzer, **9,** 128—132.

Wanke, K. G. (1955): Erfolge der Beregnung in Ober-Loiben (Wachau 1954). Der Winzer, **1,** 11—12.

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EFFECT OF FUNGICIDES APPLIED AT THE TIME OF FLOWERING ON THE POLLEN GERMINATION AND FRUIT SET OF JONATHAN APPLE TREES

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A possible damaging effect of fungicides applied at the time of flowering on the pollen germination, fruit set and yield of Jonathan apple trees has been studied under laboratory and field conditions. When pollens of apple trees come into direct contact with fungicides they give no considerable results after being germinated for 24 and 48 hours. When spraying in the field, pollens collected 24 hours later germinate with any fungicide applied. It can be stated that spraying with certain fungicides at flowering time reduces the fruit set due to the inhibition of pollen germination. This inhibition is partly or entirely compensated by meteorological factors and retarded dehiscence of anthers, and the amount of yield will not be reduced; it may even increase. Increase in the amount of yield is in relation with the fungicide effect of the plant protectives applied.

Introduction

Chemical control of fungal diseases, even at the time of flowering, is more and more widely used in apple-producing farms. The question naturally arises, whether it is necessary to spray with fungicides at this stage of development, and in which phase of flowering can control be applied without damage?

In Hungary there are two fungal diseases which cause very serious damages to apple trees: *Podosphaera leucotricha* (Ell. et Ev.) Salm. and *Venturia inaequalis* (Cke.) Wint. The virulence of these pathogens and the resistance fo apple trees at flowering time are in inverse relation. In this period the assimilating surfaces of apple trees stop increasing. It is possible that the existing assimilating surface is not able to produce sufficient amounts of assimilates to meet the requirements of flowering and fruit set. Thus the tree exhausts its nutrient reserves, thereby causing a considerable decrease in disease resistance, as it was pointed out by Csorba (1962) in relation with *Podosphaera leucotricha*, and by Kiss (1963) in relation with *Venturia inaequalis*. Chemical control during flowering may be made reasonable by the fact that in many cases flowering is protracted, therefore the possibility of infection increases. The duration of flowering is determined — besides genetic factors — by temperature, moisture, etc. The role of temperature should, however, be emphasized, since certain temperatures which slow down the rate of flowering may

be favourable for pathogenic fungi. All these factors prove the necessity of spraying at flowering time. The problem has, however, another aspect, i.e. the effect of fungicides applied at this stage on the pollen germination, fruit set and yield.

Many research workers have studied recently the question and examined pesticides from this point of view. SCHAFER (1965) found that in apple trees treated with a combination of Zineb + Karathan and a number of organic fungicides, the extent of pollination did not decrease. LIEBSTER (1965) in his two-year experiment did not observe early abscision as a reaction to treatments with fungicides and stated that commercial organic fungicides of the German Federal Republic had no unfavourable influence on fruit set. On the basis of his experiments carried out in Switzerland, ZAHOV (1963) reported a successful control over *Venturia inaequalis* by spraying apple trees in full blossom with the best-known fungicides without any unfavourable effect on the amount of yield. MINOIU *et al.* (1963) investigated the fruit set in apples, pears and sour cherries after treatments with bordeaux mixture and found that copper inhibited the fruit set. They pointed out further that all plant protectives had an unfavourable effect on pollen germination in every fruit species. EATON (1963) too, approached to the problem by using the method of pollen germination. In the course of his experiments he found that Captan 50 considerably reduced the germination percentage of pollens and inhibited the growth of pollen tubes even in a 2 per cent concentration. KASPERS (1965) sprayed in his experiment three times with 0.2 per cent Orthocid 50 during flowering and found no unfavourable effect exerted on the amount of yield. BRAUN—SCHÖNBECK (1965) reported that pollen germination in vitro was to the highest extent reduced by the fungicides Orthocid (Captan), Pomarsol (TMTD) and Delan (Dithianon), while Akricid (Binocapryl), Morestan (Chinomethionat) and Fuklasin Ultra (Thiokarbamate) had slight toxic effect on the pollens of apple trees. On the other hand with these fungicides applied percentage fruit set was found to be higher as compared to the control. According to DHURIA—HANSER—BUCHLOH (1965) Thiodan applied during blossoming had no damaging effect on the fruit set in apple tree. DONOHO (1964) established that the known plant protectives are not harmful for the yield.

When studying the data of literature we meet contradictions which can be explained by the fact, that authors have worked under different circumstances, so in their results different microclimatic factors manifest themselves. This rendered it necessary for us — when elaborating an efficient control of *Podosphaera leucotricha* and *Venturia inaequalis* — to carry out observations and experiments of our own in order to throw light upon the effects that the organic fungicides not yet introduced in practice exert on our highly important variety Jonathan under the peculiar climatic conditions of Hungary.

Material and Method

We carried on experiments for two years, in 1966 and 1967. In 1966 we performed field (in vivo) and laboratory (in vitro) tests, while in 1967 only the field experiments were replicated.

1. *Field experiments.* The material of the experiments consisted of dwarf Jonathan apple trees grafted to ÉM. IX stocks, which had abundant blossoms in both years. On the trees of the experimental area we counted an average of 500—1800 blossoms per tree in 1966 and 600—2200 in 1967. Meteorological data of the two years are presented in Table 1.

Table 1

Meteorological data of the experimental site

Year	Month	Monthly			Precipitation	
		average temperature °C	maximum °C	minimum °C	mm	frequency
1966	April	13.6	18.1	7.3	12.3	7
	May	17.1	22.4	9.7	61.4	9
1967	April	10.9	14.6	6.0	40.9	13
	May	16.9	21.4	10.8	64.4	9

a) Pollen- and fruit set examinations. In this case blossoms still in bud and those dropping their petals (brown stigmas) were removed prior to beginning the treatments. By this method flowers of approximately homogenous development stage were sprayed with the fungicides in question, according to the prescriptions. Spraying was carried out with a hand sprayer to a soaking point. In fact, we worked with a "half-tree" method that is, half of the same tree served as control. 200—700 flowers were sprayed in each treatment. We prevented the possible overlapping of sprays by spraying before noon in windless weather, and isolated half-trees with linen cloth.

The date of spraying in 1966: 6th April
in 1967: 5th May

Fruit set was evaluated in 1966 on 3—4th June
in 1967 on 20—30th June,

after the first natural fruit drop. Treatments are summed up in Table 2.

b) Yield examinations were carried out in a separate experiment with three replications. Each plot contained 21 trees. The treatments and the time of spraying were identical in the two field experiments. In these experiments spraying were carried out with the S-293 type sprayer. Chemicals were mixed in the container of the sprayer. The amount of yield was determined on the 22—23rd September in both years (Table 2).

2. *Laboratory tests.* The influence of the fungicides in question on pollen germination was studied by two methods.

a) Pollens were taken from full flowers of unsprayed trees and germinated in a hanging-drop preparation according to Daniel's method (1952) in a 10 per cent sugar solution with plant protectives of adequate concentration added. Germination percentage was determined after 24 and 48 hours by means of a microscope. Three parallel examinations were performed with each preparation. Number of examined pollens ranged from 300 to 400 in each treatment.

b) Pollen germination was studied further by collecting pollens from trees sprayed in the field 24 hours before. In this case too, germination was carried out in suspension in a 10 per cent sugar solution. Results of germination were found out 24 hours later with a microscope at 80 times magnification.

Table 2

Treatments

Examined fungicides listed by active agents	Concentration %	
	1966	1967
a) Fungicides against Fusicladium:		
Thiokarbamat		
1. Thiezene 80	0.2	0.2
2. ZMP 85	0.2	0.2
3. Antracol	0.2	0.2
4. Maneb	0.2	0.2
Captan		
5. Orthocid 50	0.3	0.3
6. Malipur 50	0.3	0.3
Dithianon		
7. Delan 50	0.075	0.075
8. IT 3296	0.05	0.05
Dodin		
9. Melprex	0.05	0.05
Copper + Thiokarbamat		
10. Kupfer-Lonacol	0.5	0.5
Diclorfluoranid		
11. Euparen 50	0.25	0.25
Thiuram		
12. TMTD	0.2	0.2
13. Polyram Combi	0.2	0.2
Folpet		
14. Ortho-Phaltan	0.25	0.25
b) Fungicides against apple mildew:		
15. Morestan 50 (Chinomethionat)	0.05	0.05
16. PP 781 (JF 2067)	0.05	0.05
17. Thiovit (Netzschwefel)	0.5	0.5
18. O control	—	—

Table 3

Pollen germination results of Jonathan apple in "in vitro" examinations

Germination medium:
10 per cent sugar solution + the examined fungicide.
Germination percentage after 24 and 48 hours

Fungicides applied	Germination percentage	
	24 hours	48 hours
Tiezene	0.0	0.0
ZMP	0.0	0.0
Maneb	0.0	1.0
Antracol	0.0	0.0
Orthocid	0.0	0.0
Malipur	0.0	0.0
Delan	0.0	0.0
IT 3296	3.5	3.5
Melprex	0.0	0.0
Kupfer-Lonacol	0.0	0.0
Euparen	0.0	0.0
TMTD	3.8	4.2
Polyram Combi	0.5	0.8
Ortho-Phaltan	3.0	3.0
Morestan	0.0	0.0
PP 781 (JF 2067)	0.8	0.8
Thiovit	0.9	1.3
Control	55.8	59.3

Table 4

Germination results on Jonathan apple pollens collected 24 hours after spraying in vivo at the time of flowering

Germination medium: 10 per cent sugar solution.
Germination percentage after 24 hours (1966)

Fungicides applied	Germination percentage after 24 hours		Difference in favour of + treated − control pollens
	Treated	Control	
Tiezene	51.6	53.4	− 1.8
ZMP	29.6	28.7	+ 0.9
Maneb	23.5	27.4	− 3.9
Antracol	63.4	41.2	+22.2
Orthocid	31.6	49.7	−18.1
Malipur	47.1	59.2	−12.2
Delan	39.6	52.6	−13.0
IT 3296	18.3	43.6	−25.3
Melprex	28.1	33.6	− 5.5
Kupfer-Lonacol	57.3	61.9	− 4.6
Euparen	56.3	50.1	+ 6.2
TMTD	43.6	40.2	+ 3.4
Polyram Combi	17.3	38.2	−20.9
Ortho-Phaltan	53.5	58.3	− 4.8
Morestan	45.6	43.8	+ 1.8
PP 781 (JF 2067)	49.6	53.2	− 3.6
Thiovit	35.6	38.2	− 2.6

Results

Experimental results are shown in Tables 3, 4, 5 and 6.

Pollens of Jonathan apple trees having got into direct contact with the examined fungicides show no considerable germination (Table 3). Maximum germination — after 48 hours — was 4.2 per cent with TMTD applied. In case of treatments carried out by using the fungicides Maneb (1 per cent), IT 3296 (3.5 per cent), Polyram Combi (0.8 per cent), PP 781 (JF 2067) (0.8 per cent) and Thiovit (1.3 per cent) pollens showed some germination. There is hardly any difference in percentage between germinating for 24 and 48 hours. Germination percentage of pollens compared to the control shows a great difference in favour of the control. According to the evidence of our results the fungicides examined in vitro inhibit the germination of pollens of Jonathan apple trees to a high extent.

Germination results of pollens collected from flowers 24 hours after spraying are included in Table 4. The results show that among the examined 17 prod-

Table 5

Percentage results of fruit set after spraying at flowering time, as compared to the control

Difference in favour of treated (+) and control (−) blossoms (1966, 1967)

Treatment	Fruit set percentage				Difference %	
	1966		1967			
	treated	contr.	treated	contr.	1966	1967
Tiezene	16.0	21.6	22.4	23.4	−5.6	− 1.0
ZNP	3.3	5.9	27.1	28.4	−2.6	− 1.3
Maneb	12.9	10.9	58.0	34.6	+2.0	+23.4
Antracol	9.2	12.4	32.5	23.7	−3.2	+ 8.8
Orthocid	9.6	14.2	20.0	12.3	−4.6	+ 7.7
Malipur	9.4	6.8	23.4	31.5	+2.6	− 8.1
Delan	11.8	16.2	24.0	29.0	−5.4	− 5.0
IT 3296	8.4	12.2	50.0	47.9	−3.8	+ 2.1
Melprex	13.9	9.2	27.3	24.1	+4.7	+ 3.2
Kupfer-L.	6.8	4.7	23.4	19.3	+2.1	+ 4.1
Euparen	13.6	15.9	20.0	26.2	−2.3	− 6.2
TMTD	11.6	12.0	28.6	32.4	−0.4	− 3.8
Polyram Combi	6.8	4.9	25.0	18.7	+1.9	+ 6.3
Ortho-Phaltan	15.8	13.3	30.0	32.6	+2.5	− 2.6
Morestan	10.7	17.6	28.0	41.6	−6.9	−13.6
PP 781 (JF 2067)	5.4	8.1	26.0	17.3	−2.7	+ 8.7
Thiovit	8.7	12.3	12.0	19.2	−3.6	− 7.2

ucts ZMP, Antracol, Euparen, TMTD and Morestan influenced pollen germination in a positive direction, as compared to the control. It is very important that in every "in vivo" treatment pollens showed sufficient germinations as compared to the control. This suggests chemical-free pollens being always present in blossom due to the fact that dehiscence of anthers does not take place at the same time within a flower.

The third part of our examinations consisted of the determination of fruit set results in plots sprayed at the time of flowering (Table 5).

When comparing the results of the two years we find that among the products applied e.g. Maneb, IT 3296, Orthocid, Malipur, Ortho-Phaltan, PP 781 (JF 2067) inhibited fruit set in one year, while promoted it in the other. Antracol and Melprex influenced the fruit set positively in both years. However, in spite of the inhibiting effect of organic fungicides on pollen germination and fruit set, no effective decrease in yield was found as proved by Table 6.

Yield shows an upward trend as compared to the control with nearly all plant protectives applied. Some decrease in yield was found in both years only when Thiovit used.

Table 6

Yield trend in kg in 1966 and 1967 on the average of 63 trees

Treatment	Yield kg/tree	
	1966	1967
Tiezene	11.0	15.0
ZMP	11.5	15.6
Maneb	10.9	14.0
Antracol	7.6	11.1
Orthocid	11.3	14.5
Malipur	10.8	14.7
Delan	12.2	15.0
IT 3296	9.6	13.8
Melprex	11.5	14.5
Kupfer-Lonacol	10.5	14.0
Euparen	11.4	14.8
TMTD	12.0	16.3
Polyram Combi	10.3	17.0
Ortho-Phaltan	9.0	14.0
Morestan	12.1	16.3
PP 781 (JF 2067)	11.8	14.7
Thiovit	8.8	13.1
O control	9.0	13.6

Summing up all results it can be established that the inhibition of the individual part processes may be influenced not only by the active agent, but also by the accompanying aggregates, emulgators, etc. and last but not least by weather. The great differences between field and laboratory treatments result partly from the influence of meteorological factors (temperature, light, precipitation) and from the special structure and behaviour of blossoms.

Our experimental results confirm the necessity of spraying with fungicides during flowering.

REFERENCES

BRAUN, H.—SCHÖNBECK, F. (1965): Untersuchungen über den Einfluß verschiedener Pflanzenschutzpräparate auf die Befruchtung von Apfelbäumen. Der Erwerbsobstbau, **7**, 26—28.

CSORBA, Z. (1962): Az almafalisztharmat (Apple mildew). Mezőgazdasági Kiadó, Budapest.

DÁNIEL, L. (1952): Pollenélettani vizsgálatok. I. Quantitativ pollenteszt (Pollenphysiological examinations. I. Quantitative pollen test). Növénytermelés, **1**, 133—150.

DHURIA, H. S.—HANSER, H.—BUCHLOTT, G. (1965): Untersuchungen über den Einfluß des Insektizids Thiodan auf Pollenkeimung und Fruchtzusatz beim Apfel. Der Erwerbsobstbau, **7**, 21—26.

DONOHO, C. W. (1964): Influence of pesticide chemicals on fruit set, return bloom, yield and fruit size of the apple. Am. Soc. Hort. Sci., **85**, 53—59.

EATON, G. W. (1963): Germination of apple pollen as influenced by captan sprays. Proc. of Amer. Soc. Horticult., **83**, 101—106.

KASPERS, H. (1965): Sind Blütespritzungen mit organischen Fungiciden im Kernobstbau bedenklich? Der Erwerbsobstbau, **7**, 28—31.

KISS, A. (1965): Növényvédelmi Tudományos Tanácskozáson elhangzott előadás (Lecture delivered at a scientific conference on plant protection). Manuscript.

LIEBSTER, G. (1965): Ergebnis 2jähriger Untersuchungen über den Einfluß während der Blüte ausgebrachter Fungizide auf Junifruchtfall und Fruchtbehang beim Apfel. Z.Pfl. Krankh. Pfl. Sch., **72**, 325—344.

MINOIU, N.—ALEXANDRI, A. V.—BAICU, T.—MARIN, A. (1965): Cercetasi cu privire la efectul produselor fitofarmacentice aplicata in timpul inflorituleu'la vita de vie si pomii fructiferi. Analele Sect. Prot. Plant., **1**, 255—271.

PORPÁCZY, A. *et al.* (1964): A korszerű gyümölcstermelés elméleti kérdései (Theoretical questions of up-to-date fruit production). Mezőgazdasági Kiadó, Budapest.

SCHAFER, H. (1965): Blütenspritzungen im Obstbau. Obst. Weinb., **101**, 258—263.

ZAHOV, T.—Захов, Т. (1965): Прьскание на овостните дървета през време на пълния цьфтеж. Природа, **5**, 102—105.

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RESISTANCE OF HARD-COATED SEEDS OF CONVOLVULUS ARVENSIS L. TO VARIOUS HERBICIDES

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Among the weeds of Hungarian field- and horticultural crops *Convolvulus arvensis* L. causes the greatest damage. In spite of a wide application of chemical weed-killers it has been repressed only to a small extent, in certain crops it has even become resistant to continued applications of amino-chlorotriazines. One of the causes of its expansion is the 90—96 per cent hard-coatedness of the seeds which can remain in the soil for years and are thus sources of repeated infections. Due to an impermeability caused by hard-coatedness — as long as this property is not changed by soil factors — seeds of convolvulus are resistant to various herbicides, as shown in author's field experiments carried out in 1967 with 1 and 3 per cent solutions of Krezonit E, 1 per cent of the herbicides Hungazin PK and K 64 and in 1968 with 3 per cent solutions of Prevenol 56 and Aminotriazol and 1 per cent of Karmex sprayed over the soil surface, further with Avadex (Diallate) and Avadex BW (Triallate) worked in 1 per cent concentration; and in his laboratory experiments when using the same herbicides. In future programs of weed control special attention should be paid to Convolvulus and — in general — to weeds with hard-coated seeds.

Introduction

In order to increase yields in field crops many up-to-date methods of weed control have been employed during the last decade. The use of various herbicides has, however, caused changes in the weed flora. In Hungary, the covering percentage of the majority of important weed species either show somewhat decrease or has remained the same as before the application of herbicides (ÚJVÁROSI 1966). In certain cases, with a continued application of herbicides, the original weed flora has changed into a weed population consisting mostly of resistant types (UBRIZSY 1967).

A new method of making herbicides more efficient is to apply them under the soil surface. UBRIZSY (1963) considers the application of soil sterilizing herbicides to be an important step. Herbicides that got under the soil surface can be successfully used in controlling deep-rooted perennials and weed-seeds germinating in deeper soil layers (BÁNKI—BIHARI 1967, KING 1966).

According to HARPER (cit. KING 1966) methods of soil cultivation without ploughing make it superfluous to work in the herbicides, as weed-seeds

fallen to the ground are killed by the herbicides even when the latter are sprayed over the surface of the soil. By ploughing and hoeing weed-seeds get from the surface to deeper layers of soil and provide reserves for weed infections for a long time. Thus, from the point of view of chemical weed control soil cultivation has become undesirable.

Apart from foreign experimental results attempts have been made also in Hungary to apply "Krezonit E" (containing dinitro-orto-krezol as active agent) for soil sterilization. SZEPESSY (1964) obtained relatively good results in sugar beet and maize stand grown in small plots. Similar results were reported by CZIMBER (1964) on his culture pot experiment against seeds of *Cuscuta* species. KUROLI's successful laboratory results (1965) were not confirmed by his large-scale experiments which he explained by soil sterilization with "Krezonit E" applied at the wrong time and in too small doses.

As for the experiments of all the three authors it should be noted that the herbicide was applied as sprayed over the soil surface.

Besides the general problems outlined above concerning the effect of herbicides, *Convolvulus arvensis* L. is worth of special attention in Hungary. According to ÚJVÁROSI (1957), 15 years ago, with a covering percentage of 6.895, convolvulus was in the first place among the weeds on the national average, i.e. accounted for 21.8 per cent of the national total. Though since then its covering percentage has decreased (from 6.895 to 5.238 percent), *Convolvulus arvensis* L. is — even today — in the first place (ÚJVÁROSI 1966). This weed called further attention by becoming resistant to triazine in certain crops. According to UBRIZSY's observations (1966, 1967, 1968), in Hungarian vineyards the earlier traditional weed population, *Amarantho-Chenopodietum*, has been replaced by the *Convolvulo-Portulacetum* association which consists of far less weed species — almost exclusively of *Convolvulus* (in 80 per cent) — but of resistant types.

Herbicides applied in deeper layers of soil may exert a high killing effect on many-budded convolvulus rhizomes. Absolute attention should be paid however, to convolvulus seeds present in soil in great numbers, as they may be sources of repeated infestations. Namely, due to their high per cent hard-coatedness (CZIMBER—REISINGER 1968) they may not only survive for years in soil (ÚJVÁROSI 1957), but even resist the herbicides applied. The only exception is the small percentage in which this property either did not develop, or under the influence of various factors (mechanical injury of the seed coat, effect of microorganisms on the seed coat, frost, etc.) ceased to exist. In his report KISS (1964) speaks about the problems of chemical weed control in the wine growing district of Mór as "convolvulus problem". A more successful control can be exercised over it by applying more efficient herbicides, as well as using herbicides of different effect mechanisms every year (herbicide

rotation). SRIPLENG—SMITH (1960) also consider the reproduction by seed to be an important factor in any program of controlling convolvulus.

Herbicide resistance of hard-coated seeds is caused by their epidermis cell walls being thickened and impregnated with lignine, cutine or suberine (SRIPLENG—SMITH 1960). This is undoubtedly the layer which is responsible for impermeability of the seed-coat to water and gas. Without them, however, the process of germination cannot start. The layer thus impregnated causes the "hard-coatedness" of seeds, so herbicides either in water solutions or in gaseous state cannot penetrate them and their germ-killing ability remains ineffective. On the other hand, when the effect of herbicides applied into the soil has ceased — and if the cell layer recovers its permeability under the influence of previously mentioned factors — seeds germinate without any injury and develop new plants.

Experiments described in this paper were carried out to prove the above exposition.

Material and Method

In order to prove the resistance of hard-coated convolvulus seeds to contact- and root herbicides we started laboratory and field experiments in 1967 and 1968. As herbicides we used 1 and 3 per cent solutions of "Krezonit E" containing dinitro-orto-krezol (DNOC-ammonium salt), 1 per cent solution of "Hungazin PK" containing Aktinit PK as active agent, 1 per cent solution of "K 64" with an active agent combination of Hungazin PK, Ametrin and Dikonirt, furthermore, 3 per cent solutions of Aminotriazol and Prevenol 56 (CIPC) as well as solutions of Avadex (Diallate), Avadex BW (Triallate) and Karmex (DCMU) sprayed in 1000 litre water per ha. Avadex and Avadex BW were worked in prior to ploughing. In laboratory tap water was used for irrigation as a control. Both in the laboratory and in the field we worked with two series.

In one of the series scarified seed (D), in the other untreated ones (KL), — i.e. those in the state of hard-coatedness — of convolvulus were sprayed with each of the above mentioned herbicides. By using scarified seeds we intended to obtain data on the extent of germicidal capacity in herbicides.

Under laboratory conditions 100 seeds per treatment were germinated at room temperature for 15 days. Seeds that had not germinated were washed out once, thus freed from the effect of herbicides; after having been scarified and treated with tap water they were placed again into an incubator in order to make certain of their previous herbicide resistance caused by the anatomical structure of the seed coat.

Our field experiments were started on the 10th May 1967 and on the 17th April 1968 respectively, at the Experimental Field Station of the College of Agricultural Sciences, Mosonmagyaróvár, on an alluvial area of the Danube. 400 seeds per treatment were sown in 1.5×1 m plots with a spacing of 4×10 cm, at a depth of 3—4 cm. Thus, in the 10 and 12 plots respectively of the two experiment series started in 1967 and 1968 a total of 8800 seeds were required. This quantity was collected in autumns of 1966 and 1967 at the field station of our Institute. Seeds were stored before sown at room temperature.

Results

The results of laboratory germination are summarized in Table 1. In the scarified (hard-coated) serie swelling and germination occurred only at an extent corresponding with the percentage of normal coated seeds in each treatment. Owing to the germicidal effect of 1 and 3 percent Krezonit E and K 64

Table 1

Germination of Convolvulus arvensis seeds treated with various herbicides under laboratory conditions

Time of starting the germination experiment	Treatments		Seeds germinated — and swollen or mouldy respectively — from 100 seeds per treatment						
			Non-scarified series				Scarified series		
			Germinated		Swollen or mouldy	Germinated after washed out and scarified	Germinated		Swollen or mouldy
			number	per cent			number	per cent	
April 2, 1967	Krezonit E	1%	—	—	8	92	—	—	93
	Krezonit E	3%	—	—	2	98	—	—	96
	Hungazin PK	1%	2*	2	10	88	74*	74	19
	K 64	1%	—	—	4	96	—	—	97
	Control		4	4	2	94	90	90	5
March 22, 1968	Aminotriazol	3%	3*	3	3	94	93*	93	3
	Avadex (Diallate)	1%	4*	4	4	92	95*	95	2
	Avadex BW (Triallate)	1%	3*	3	4	93	90*	90	5
	Karmex	1%	4*	4	4	92	96*	96	2
	Prevenol	3%	5*	5	3	92	93*	93	4
	Control		4	4	2	94	94	94	4

* Seeds germinated but seedlings with two cotyledons were killed by the herbicide.

no germination — even of a minimum — occurred. In the other treatments the few seeds that germinated were killed after 1 or 2 weeks. Swollen or mouldy seeds can be considered as originally normal coated. Namely, normal coated seeds absorb water through their permeable seed coats and swell, but — owing to the active agent solved in it — cannot germinate. Hard-coated seeds which had not germinated, had not even swollen, after having been washed out, scarified and repeatedly germinated developed healthy seedlings. This fact proves that — when first germinated — owing to the impermeability of their seed coats they could not take up either water or water-solved active agents, so they resisted the effect of herbicides. Some phytotoxic effect was observed in seedlings developed from seeds treated originally with Karmex; these seedlings were retarded in growth as compared with plants in the other treatments. The results of the scarified series prove the same. Seeds freed previously from hard-coatedness became permeable and swelled, but owing to the inhibitory effect of chemicals — except for the controls — those treated with Krezonit E and K 64 did not even start to germinate. In the other treatments the

seedlings were killed at different stages of development. In these treatments the killing effect of herbicides on seedlings showed the following trend:

Hungazin PK: Seedlings reached one-leaf stage while their cotyledons became more and more etiolated. Even their first leaves had no chloroplasts when unfolding, and before obtaining the shape characteristic of the species, the plants died.

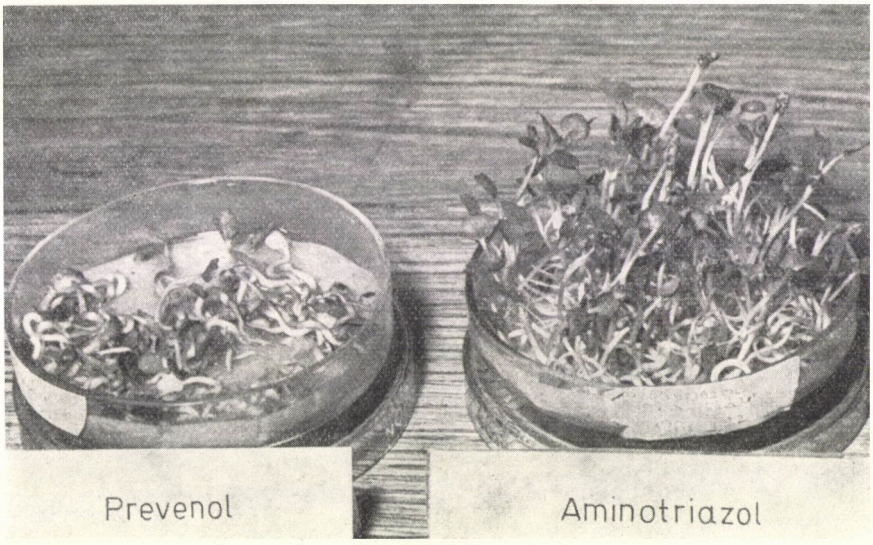

Fig. 1. Development in 3 percent solutions of Aminotriazol and Prevenol of seedlings grown from scarified *Convolvulus arvensis* seeds

Aminotriazol: Every seed germinated and developed healthy green cotyledons; the latter became, however, etiolated in a short time and the plants collapsed and died. Hypocotyls of some plants were elongated (Fig. 1).

Avadex (Diallate): Seedlings developed with mostly etiolated cotyledons of various shape and size, but these too withered in a short time.

Avadex BW (Triallate): Symptoms were similar to those observed with seed treated with Avadex. Hypocotyls were shorter and thicker.

Karmex: The relatively short radicles became gradually brown and withered. Initially light green cotyledons were etiolated and rapidly withered. Cotyledons of some plants remained within the seed coat.

Prevenol 56: All seeds developed initially healthy seedlings, the absorbing zone of which became, however, brown, showing the symptoms of root tip withering. Partly developed yellowish green and whitish yellow cotyledons did not grow, became tinder-like, thick, and cotyledons partly remained within the seed coat. Hypocotyls were very short, lying and thickly curved (Fig. 1).

Table 2

Germination of Convolvulus arvensis seeds treated with various herbicides under field conditions

Time of starting the experiment	Treatment		Number of seeds germinated from 400 seeds per treatment			
			non-scarified series		scarified series	
			germinated			
			number	per cent	number	per cent
May 10, 1967	Krezonit E	1%	13	3.25	182	45.50
	Krezonit E	3%	6	1.50	74	18.50
	Hungazin PK	1%	2	0.50	88	22.00
	K 64	1%	—	—	—	—
	Control		13	3.25	269	67.25
April 17, 1968	Aminotriazol	3%	11	2.75	78	19.50
	Avadex (Diallate)	1%	7	1.75	95	23.75
	Avadex BW (Triallate)	1%	1	0.25	82	20.50
	Karmex	1%	10	2.50	80	20.00
	Prevenol 56	3%	6	1.50	98	24.50
	Control		7	1.75	37	9.25

In the scarified series the sum of germinating and swollen seeds of the individual treatments is smaller than the total number of seeds, because, with scarification made only once, several hardcoated seeds checked only by germination are left behind in most cases.

Experiments performed under field conditions can be evaluated on the basis of data presented in Table 2. In the untreated, non-scarified series (KL) in both years we obtained germination results corresponding generally with the percentage occurrence of normal-coated seeds only (Fig. 2). Germinating seeds were completely killed by K 64. In each plot of this series 100 seeds were sown in a plastic net bent into a V-shape, so more seeds were easily washed out of soil in order to make sure by a repeated germination — but this time after scarification — about their resistance to contact and root herbicides while in the state of hard-coatedness (impermeability). This time germination took place in Petri-dishes. Seeds removed from soil were intact and healthy and developed viable plants.

In the scarified field series (D), in the experiments performed in 1967, in every treatment except for K 64, a high number of seeds developed one-leaf seedlings up to the time of evaluation. 88 seedlings germinated in the treatment sprayed with Hungazin PK showed symptoms of etiolation even at the stage of two cotyledons, and several days later died. In plots treated with 1 and 3 percent solutions of Krezonit E viable plants developed from a relative-

Fig. 2. Untreated (KL), i.e. hard-coated convolvulus seeds sown in control plots rest for several years in soil without germination

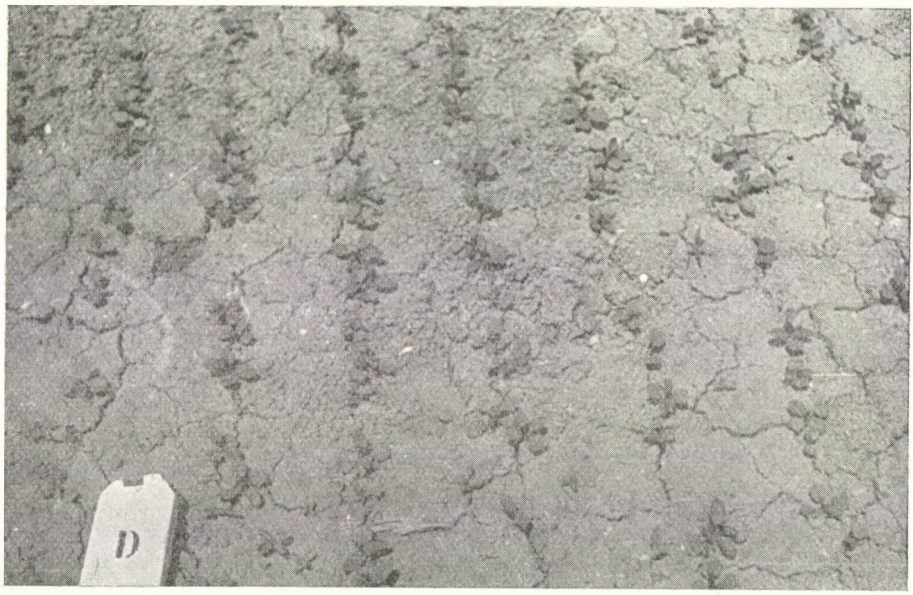

Fig. 3. Treatment of previously scarified (D) seeds in control plots

ly high number — 182 and 74 respectively — of seeds. The highest number of seeds (67.25 per cent) germinated in the control plots — similarly to the scarified laboratory experiment series — as shown in Fig. 3. In the scarified field series sown in 1968 the applied chemicals had no phytotoxic effect on seedlings germinated in a low number, which was probably due to a prolongated dry weather prevailing after sowing. Herbicides could not kill scarified seeds in the soil either, as proved by the especially low germination percentage (9.25) of the control.

Conclusions

Results of experiments carried out both under laboratory and field conditions proved that hard-coated seeds of *Convolvulus arvensis* L. were not injured by herbicides used as "soil sterilizers". Namely, due to their impermeability, seed-coats do not let water-solved herbicides through as long as — under the influence of numerous factors arising in soil — they become permeable. In the case of convolvulus, however, these permeability-inducing factors develop slowly, during several years, and appear usually after the decomposition of the active agents. Thus, hard-coated convolvulus seeds long surviving in soil resist the periodical applications of herbicides, make repeated damages to our cultivated plants and by producing seeds increase the weed-seed content of soils. Therefore in future chemical weed control programs this property of the hard-coated seeds of convolvulus and other plant species should be taken into consideration.

All herbicides applied in our experiments had perfect effect on permeable (scarified) convolvulus seeds under laboratory conditions only.

REFERENCES

BÁNKI, L.—BIHARI, F. (1967): Újabb gyomirtószerek és szerkombinációk a nagyüzemi gazdálkodásban (New herbicides and herbicide combinations in largescale farming). Magyar Mezőgazdaság, **34**, 30—31.

BENCZE, J. (1954): Iregszemcse, Pusztapó, Bánkút mezőségi talajainak gyommagfertőzöttsége (Weed-seed infestation of meadow soils at Iregszemcse, Pusztapó and Bánkút). Agrártud. Egyet. Agr. Kar. Kiadv. I.

CZIMBER, GY. (1964): Előkísérletek a talajban elfekvő arankamagvak csírázóképességének megsemmisítésére (Preliminary experiments on destroying the germinative ability of dodder seeds resting long in soil). Mosonmagyaróvári Agrártud. Főisk. Közlem., **7/5**, 11, 15.

CZIMBER, GY.—REISINGER, M. (1968): A *Convulvulus arvensis* keményhéjú magvainak a talajsterilizáló és gyökérherbicidekkel szembeni ellenállóképessége (Resistance of hard-coated seeds of *Convolvulus arvensis* to soil sterilizers and root herbicides). Növénytermelés, **17**, 249—257.

KISS, Á. (1964): A móri borvidék gyomvegetációja és a vegyszeres gyomirtás problémái (Weed population of the wine growing district of Mór and problems of chemical weed control). Növényvéd. Kut. Int. Évk., **9**, 137—152.

KING, L. J. (1966): Weeds of the world. Leonard Hill Books, London—New York.

KUROLI, G. (1965): Komplex irányú talajfertőtlenítési kísérletek (Experiments on complex soil sterilization). Növényvédelem, **4,** 8—17.

SRIPLENG, A.—SMITH, F. H. (1960): Anatomy of the seed of *Convolvulus arvensis*, Amer. J. Bot., **47,** 386—392.

SZEPESSY, I. (1964): A komplexirányú talajfertőtlenítésről (On complex soil sterilization). Növénytermelés, **13,** 177—188.

UBRIZSY, G. (1963): A vegyszeres gyomirtás legújabb eredményei (Recent developments in chemical weed control). Mezőgazdasági Világirodalom, **5/1,** 9—18.

UBRIZSY, G. (1966): Gyomirtószerfogó — Újabb eredmények a szőlő vegyszeres gyomirtásában (Contact herbicides — Recent developments in the chemical weed control of vineyards). Kertészet és Szőlészet, **15,** 8—9.

UBRIZSY, G. (1967): Újabb irányok és eredmények a vegyszeres gyomirtásban (New trends and results in chemical weed control). MTA Agr. Oszt. Közlem., **16,** 67—86.

UBRIZSY, G. (1968): Long-term experiments on the flora-changing effect of chemical weed killers in plant communities. Acta Agronomica Acad. Sci. Hung., **17,** 171—193.

UJVÁROSI, M. (1957): Gyomnövények, gyomirtás (Weeds and weed control). Mezőgazdasági Kiadó, Budapest.

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CATION-DEPENDENT EFFECT OF CHLORIDE ON THE PHOTOSYNTHETIC CARBON DIOXIDE FIXATION BY BEAN LEAVES

By

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Pro anal. potassium chloride as well as pro anal. and puriss. ammonium chloride increase the intensity of photosynthetic carbon dioxide fixation, while pro anal. sodium chloride and techn. ammonium chloride inhibit it as compared to the distilled water control. In the cation-dependent effect of chloride the size of the hydrate layer of the cation probably plays a more important role than the ion radius of the cation does. Thus, it is not the chloride and ammonium attached to it respectively, but natrium that exerts an inhibiting effect on plant metabolism.

Introduction

Chloride anion stimulates some biochemical reactions of photosynthesis and photophosphorylation through a biocatalytic activity (Arnon 1961). According to Haas (1944) the chloride treatment produced an inhibition of biological metabolism in many cultivated plants. In other experiments the stimulation of photosynthetic carbon dioxide fixation as a reaction to ammonium chloride fertilization was demonstrated (Kiss—Kiss—Pozsár 1968); in contrast to the unfertilized control, however, ammonium chloride stimulation was slightly inferior to the effect of a complex NPK fertilization. With these data taken into consideration the effect of chloride on the intensity of photosynthetic carbon dioxide fixation was directly studied on a biological test.

Material and Method

Disc samples were excised of primary leaves of Pinto bean and floated for 18 hours on water, pro anal. sodium chloride of 10^{-3} mol, potassium chloride and ammonium chloride, puriss. and techn. ammonium chloride, respectively. In order to achieve the most perfect possible elimination of characteristic instability of biological materials, a disc prepared of identical leaves were floated on the different solutions. Photosynthetic carbon dioxide fixation was determined subsequently by 20 minute exposition in a 5 l exsiccator containing 120 μC activity, from $Ba^{14}CO_3$ with 130 mC/g specific activity, according to Arnon's (1961) method. Radioactivity was measured by the liquid scintillation method and expressed in cpm with the mean error of the mean value ($E = \frac{\Sigma(x - \bar{x})}{n}$ indicated (Sváb 1961). Chlorophyll content was determined by Holden's (1965) method, and the specific activity per mg was expressed in cpm. Technical ammonium chloride for experimental purposes was obtained from the Borsodi Vegyi Kombinát (Borsod Chemical Works).

Results

According to experimental data (Table 1) pro anal. potassium chloride as well as pro anal. and puriss. ammonium chloride stimulate, while the pro anal. sodium chloride and techn. ammonium chloride inhibit the intensity of photosynthetic carbon dioxide fixation, as compared to the distilled water

Table 1

Cation-dependent effect of chloride on photosynthetic CO_2 fixation by Pinto bean leaves, in a 20 minute exposition, related to 0.87 mg chlorophyll, after floated for 18 hours on solution of 10^{-3} mol, as compared to a distilled water control

Water content of leaves is 67.0 per cent

Treatment	Quality	Light fixation cpm/250 mg fresh weight	Mean error of mean value	Dark fixation cpm/250 mg fresh weight	Mean error of mean value	Photo-synthetic CO_2 fixation cpm/250 mg fresh weight	Specific activity	
							cpm/mg	%
H_2O		38 410	3123	1970	161	36 440	41 885	100
NaCl	pro anal.	31 325	2521	2132	174	29 193	33 555	80
KCl	pro anal.	45 917	3730	1050	86	44 867	51 571	123
H_4NCl	pro anal.	49 381	4057	2238	186	47 143	54 187	129
H_4NCl	puriss.	52 405	4291	2132	194	50 273	57 670	137
H_4NCl	techn.	33 781	2739	2355	164	31 426	36 121	86

control. Data presented show a cation-dependent activity of chloride as regards photosynthetic carbon dioxide fixation. The size of the hydrate layer of cation is supposed to play a more important role in the cation-dependent effect of chloride, than the ion radius of cation does. In this sense, it is not chloride and ammonium attached to it respectively, it is pro anal. sodium and technical ammonium chloride supposedly contaminated with sodium chloride, that exert an inhibiting effect on plant metabolism.

REFERENCES

ARNON, D. I. (1961): Cell-free photosynthesis and the energy conversion process. In: W. D. MCELROY—B. GLASS: Light and life. J. Hopkins Pr., Baltimore.

HAAS, A. R. C. (1944): Influence of chloride on plants. Bot. Gaz., **106,** 179—184.

HOLDEN, M. (1965): Chlorophylls. In: T. W. GOODWIN: Chemistry and biochemistry of plant pigments. Acad. Pr., New York.

KISS, B.—KISS, A. S.—POZSÁR, B. I. (1968): Effects of technical ammonium chloride on the photosynthetic carbon dioxide fixation ($^{14}CO_2$) and protein synthesis in maize leaves. (In the press.)

SVÁB, J. (1961): Statisztikai módszerek mezőgazdasági kutatók részére (Statistical methods for agricultural research workers). Mezőgazdasági Kiadó, Budapest.

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STUDY ON THE SEEDLING WEIGHT AND ENDOGENOUS DEHYDROGENASE ACTIVITY OF INBRED LINES AND SINGLE AND DOUBLECROSS HYBRIDS OF MAIZE

By

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It was found that formasane production in embryos of single- and double-cross hybrids was higher than that in their parents. Seedling weight of the hybrids was also higher than that of their parents. A close positive correlation was found ($r = +0.774$ and $r = +0.981$ respectively) between the formasane production and shoot-root weight ratio of single- and double-cross hybrids. In the case of inbred lines such correlation could not be found. In our opinion a study on the shoot/root weight ratio and formasane activity at seedling stage may be suitable for a preliminary laboratory selection of heterotic hybrids of good combining ability.

Introduction

The phenomenon of heterosis has been studied from many aspects during the past years. By means of biochemical examinations a difference in catalase and peroxidase activity between the crossing partners and their hybrids could be demonstrated (HAGEMAN *et al.* 1962, SCHRADER *et al.* 1966, IRNAZAROV—KALININ 1966). GOLUNSKAYA *et al.* (1965) and GÖRING—HOFFMANN (1966) pointed out that in the vegetative organs of hybrids the amount of chlorophyl and dry matter content increased. MCDANIEL—SARKISSIAN (1966) studied the oxidation and phosphorilation activities in the mitochondria of inbred lines and hybrids. Germinating power and initial growth of embryos in hybrid maize seeds were studied by FEDOROV—TEPLOVA (1962), DOROVSKAYA (1965), EL ERYANI—FLEMING (1966), GÁSPÁR (1963) and BARANOVSKY—GARMS (1966). On the basis of their investigations they pointed out that from the growth intensity and development of seedlings conclusions could be drawn regarding the extent of heterosis, and through this there was a possibility to select lines of good combining ability. MALATKOVSKY (1966) elaborated the principle of polarity as an explanation of the phenomenon of heterosis. In his opinion, the higher the polarity — that is, the ratio of aboveground and underground plant parts — the higher the heterosis effect.

By reviewing the literature we have seen that dehydrogenase activity of inbred lines and hybrids of maize — especially in the initial stage of seed germination — has not been studied.

The trend of shoot and root weight in seedlings of domestic bred lines and hybrids, as well as the physiological index of hybrid vigour have also been studied to a limited extent only. To make up for these deficiencies we carried out experiments in 1966—67 to determine the total endogenous activity of dehydrogenase systems in embryos of seeds of inbred lines, single and double crosses of maize, as well as the shoot and root weight of seedling.

Material and Method

The following inbred lines were used in our experiments: C5, 0118b, N6, WF9, 156, M14 and 01. The inbred lines were placed at our disposal by the Hybrid Farm of Martonvásár. Out of the seed samples of single cross hybrids the 156 × M14, 156 × N6, WF9 × M14, WF9 × N6 and 0118b × 156 originated in 1966 from certified seed lots. The single cross hybrids C5 × 0118b, C5 × N6, C5 × WF9, C5 × 01, N6 × 0118b and 0118b × 01 were produced in 1967 at the Variety Identifying Station of the National Seed Inspectorate, Monor.

The endogenous activity of total-dehydrogenase systems in embryos was determined in the following way in distilled water and in a solution containing succin acid substrate: 4 × 10 grains per sample were soaked in 30 °C water for 20 hours, then cut into two with a blade along the embryo; the two halves were removed and placed in distilled water.

The composition of the incubation solution was as follows: 3 ml 1 per cent 2,3-5-triphenyl-tetrazolium-chloride, 2 ml 0.1 M succinic acid and 2 ml distilled water. The pH-value of the incubation solution was adjusted to 6.6 with KOH-solution. Incubation took place in an ultrathermostat at a temperature of 30 °C, for 20 hours. After incubation the test-tubes were placed for 10 minutes in a water-bath at 100 °C, partly to stop enzyme activity and partly to make the release of the produced formasane easier. Formasane was released from the cells with acetone and extinction was determined at 480 nm with a Spektromom 360-type photometer. On the basis of the determined extinction the amount of formasane produced was read from a standard curve determined with pure formasane solution. We used tetrazolium as indicator because according to the literature (JÁMBOR—DÉVAY 1959) it is suitable for determining the total dehydrogenase activity of plant tissues.

The germinative ability of samples was determined with 2 × 50 grains in a paper roll at 20 °C. Germination was evaluated on the seventh day. Shoot- and root weight, dry matter weight and dry matter percentage of etiolated seedlings were established from the sample used to determine the germinative ability. Only seedlings considered intact in the germination test were used for the determination of dry matter production. The amount of formasane produced by the embryos is given as related to 1 g embryo-dry matter, while seedling weights to one seedling, in mg. Experimental data obtained were statistically evaluated at a level of P = 5 per cent.

Results

Table 1 shows the total endogenous activity of dehydrogenase systems in lines and single and double cross hybrids examined in our experiment in solutions with and without succin acid substrate.

It can be well observed from the table that the activity determined in watery solution of dehydrogenase systems of single and double cross hybrids was higher than the activity of lines. Dehydrogenase activity expressed in formasane production of single and double cross hybrids showed a high individual fluctuation, but comparing the hybrids with the respective parent partners we saw that they surpassed their parents in activity in every case.

Table 1

Formasane production in embryos of inbred maize lines, as well as single- and double-cross hybrids without substrate and in a 3.5×10^{-1} mol succin acid solution at 30 °C, in 20 hours

Sample	mg formasane/1 g dry matter	
	without substrate	in succin acid
Lines		
01	28	35
WF9	31	25
0118b	34	34
C5	37	33
N6	42	37
156	51	38
M14	53	35
Single cross hybrids		
WF9×M14	64	49
WF9×N6	51	45
156×M14	55	37
156×N6	60	45
0118b×156	91	52
0118b×01	46	40
C5×0118b	44	36
C5×N6	72	59
C5×WF9	54	45
C5×01	59	56
N6×0118b	44	36
Double cross hybrids		
Mv 1	82	40
Mv 5	56	37
Mv 602	43	38
Mv 59	39	35

By considering lines, single and double cross hybrids as groups, we examined whether the dispersion in the formasane production of embryos can be considered uniform. Results of homogeneity tests are presented in Table 2. According to the data of the table no significant difference in the fluctuation of formasane production could be found between the individual groups.

The total dehydrogenase activity determined in a solution containing succin

Table 2

Results of homogeneity tests of formasane production in embryos of seed samples from lines, single and double cross hybrids

Group	FG	s^2	χ^2	Common χ^2
Lines	6	93.63	2.94	
Single cross hybrids	10	193.57	10.13	7.36
Double cross hybrids	3	366.66	5.92	

Table 3

Germinative ability of seeds in lines, single and double cross hybrids; fresh weight of shoots and roots of seedlings, and trends of shoot/root weight ratios

Sample	Germinative ability %	Shoot	Root	Whole plant	Shoot/root weight ratio
		fresh weight mg/1 plant			
Lines					
01	96	331	183	514	1.8
WF9	32	63	95	158	0.7
0118b	77	218	98	316	2.2
C5	90	147	115	262	1.3
N6	95	191	152	343	1.3
156	92	245	120	365	2.0
M14	76	149	91	240	1.6
Single cross hybrids					
WF9×N14	77	589	298	887	2.0
WF9×N6	95	469	348	817	1.3
156×M14	94	563	256	819	2.2
156×N6	91	528	178	706	3.0
0118b×156	91	551	144	695	3.8
0118b×01	68	353	227	580	1.6
C5×0118b	98	408	309	717	1.3
C5×N6	100	351	211	562	1.7
C5×WF9	100	426	298	724	1.4
C5×01	100	458	379	837	1.2
N6×0118b	100	482	427	909	1.1
Double cross hybrids					
Mv 1	80	508	152	660	3.3
Mv 5	96	504	216	720	2.3
Mv 59	96	344	284	628	1.2
Mv 602	96	456	374	830	1.2

Table 4

Dry weight and dry matter percentage of shoots and roots of seedlings, as well as trends of shoot/root weight ratios in lines, single and double cross hybrids

Sample	Shoot	Root	Whole plant	Shoot	Root	Whole plant	Shoot/root weight ratio
	dry weight mg/1 plant			dry matter %			
Lines							
01	21.3	13.4	34.7	6.43	7.32	6.75	1.6
WF9	6.1	7.2	13.3	9.68	7.57	8.72	0.8
0118b	16.3	9.6	25.9	7.47	9.79	8.20	1.7
C5	12.4	10.2	22.6	8.43	8.86	8.62	1.2
N6	14.5	11.1	25.6	7.59	7.30	7.46	1.3
156	15.5	9.9	25.4	6.32	8.25	6.96	1.6
M14	9.0	5.5	14.5	6.04	6.04	6.04	1.6
Single cross hybrids							
WF9×M14	36.7	23.2	59.9	6.23	7.78	6.75	1.6
WF9×N6	32.7	28.7	61.4	6.97	8.24	7.51	1.1
156×M14	33.0	18.5	51.5	5.86	7.22	6.29	1.8
156×N6	32.2	16.0	48.2	6.09	8.98	6.83	2.0
0118b×156	33.5	11.5	45.0	6.07	7.98	6.47	2.9
0118b×01	22.0	18.7	40.7	6.23	8.23	7.01	1.2
C5×0118b	22.5	23.1	45.6	5.51	7.47	6.35	1.0
C5×N6	25.1	17.8	42.9	7.15	8.43	7.63	1.4
C5×WF9	28.8	22.0	50.8	6.76	7.38	7.01	1.3
C5×01	29.9	22.3	52.2	6.52	5.88	6.24	1.3
N6×0118b	34.8	33.1	67.9	7.21	7.75	7.47	1.1
Double cross hybrids							
Mv 1	32.3	12.8	45.1	6.35	8.42	6.83	2.5
Mv 5	33.6	18.4	52.0	6.66	8.51	7.22	1.8
Mv 59	24.8	23.9	48.7	7.20	8.41	7.75	1.0
Mv 602	33.3	33.3	66.6	7.30	8.90	8.02	1.0

acid substrate was the highest in the embryos of single cross hybrids. The average activities of lines and double cross hybrids were nearly on the same level.

The difference of average endogenous activity between lines and single cross hybrids was significant at the level of P = 5 per cent. However, between the average endogenous activity of single and double cross hybrids no significant difference could be proved.

Succin acid substrate inhibited the formasane production of embryos in

Table 5

Results of homogeneity tests of dry matter production in 7 days old seedlings from seed samples of lines, single and double cross hybrids

Group	FG	s^2	χ^2	Common χ^2
Lines	6	56.30	4.85	
Single cross hybrids	10	71.72	10.31	0.22
Double cross hybrids	4	88.94	3.83	

every case except in the lines 01 and 0118b. In embryos of single and double cross hybrids this inhibition was of considerable extent in certain cases.

Table 3 presents the fresh weight of seven days old embryos in single and double cross hybrids, while Table 4 the dry weight and dry matter percentage of embryos. The data clearly show the great difference in weight occurring between inbred lines and hybrids originating from them even at seedling stage.

All seedlings of single-cross hybrids were superior to their parent both in fresh weight and dry matter production. Fresh weight of seedlings of double cross hybrids was also significantly higher than that of the lines, but remained, on the average, below that of the single crosses.

In a way similar to the method used when examining formasane production, by considering lines, single and double cross hybrids as groups, we examined whether the dispersion of dry matter production can also be considered as homogenous. Results of homogeneity tests are presented in Table 5. Data of the table show that between the individual groups no significant difference in dispersion was found.

In dry matter production there is a significant difference between lines and single cross hybrids, as well as between lines and double cross hybrids. Between single and double cross hybrids, however, the difference was not significant.

The shoot/root weight ratio of seedlings in lines, as well as in single and double cross hybrids examined showed a high individual fluctuation.

In case of single and double cross hybrids a close positive correlation was found between the shoot/root weight ratio index expressed in dry weight of seedlings and formasane production of embryos. The value of correlation coefficients between the above mentioned two variants was $r = +0.774$ in single cross hybrids and $r = +0.981$ in double cross ones. The correlation coefficient obtained in single cross hybrids was significant at a level of $P = 1$ per cent, while in double cross hybrids at $P = 2$ per cent.

No correlation was found between the formasane production of embryos and the shoot/root weight index of seedlings in inbred lines.

The dry matter percentage of seedlings was generally lower in single cross hybrids than either in double cross seedlings or in lines.

Discussion

Examinations of many inbred maize lines and hybrids derived from them showed that the total endogenous activity of dehydrogenase systems in hybrids was higher compared to the parents.

The activity of the dehydrogenase system within the cell was measured on the basis of the amount of formasane produced. Since tetrazolium salts compete with the normal electron transport system, its activity can be easily characterized by the amount of formasane released in the cell, even if it is not proportional to it.

In our experiment we used a long period of incubation in determining dehydrogenase activity, owing to the considerable amount of endogenous substrates and the slow penetration of TTC into the relatively large amount of embryonal tissue. At the same time we took care that results are not influenced by microbal infections often occurring in such cases. Microbal infection was prevented by using an adequate TTC concentration.

The higher formasane production of hybrids as compared to their parents can be attributed to heterosis. This agrees to data already recorded in literature suggesting that heterosis is manifested also in an increased respiration activity of hybrids.

When comparing the formasane production of double cross hybrids studied in our experiments with the same index of their single cross parents, we found that formasane production decreased in the former. For example, formasane production determined in a substrate-free solution in embryos of the double cross hybrid Mv 602 was lower than that of its seed parent (WF9 $\times$ $\times$ N6). The situation was the same with the Mv 59 hybrid, in which the formasane production of both parents (C5 $\times$ N6 and 0118b $\times$ 156) exceeded that of the double cross hybrid. From these data we may draw the conclusion that in the embryos of double cross hybrids the dehydrogenase activity decreases.

Higher formasane production in hybrids as compared to the parent lines may be the result of their higher substrate content on one hand, and increased enzyme activity, on the other. However, the inhibiting effect of succin acid substrate (3.5×10^{-2} M) on formasan production suggests, that the heterosis of hybrids manifests itself in the higher endogenous substrate content of cells rather than in an increased enzyme activity.

The high endogenous substrate content is confirmed by the observation that it was in those hybrids (WF9 $\times$ M14, 0118b $\times$ 156, Mv 1) that succin acid substrate inhibited formasane production to a high extent, which showed

considerable endogenous activity. At the same time, in inbred lines applied substrate concentration either stimulated, or slightly inhibited formasane production. Experiments are being carried out to study the inhibition mechanism of formasane production under the influence of exogenous substrates.

The relatively low dry matter percentage of single cross hybrid seedlings due probably to the higher metabolic activity of their cells is interesting.

When studying shoot/root weight ratios we found that among the 11 single cross hybrid combinations in five cases, hybrids exceeded the ratio of their parents, and developed large crowded shoots as compared to their roots. In two cases the shoot/root weight ratio of hybrids was lower than that of both parents, while in four cases it showed an intermediate trend. Between shoot/root weight ratio and formasane production a close positive correlation could be demonstrated in the hybrids. While comparing the shoot/root ratio values with the formasane production of embryos, we find that formasane production in embryos of crossings indicating an overdevelopment on the basis of this index also gives prominent values.

When comparing the shoot/root ratio and formasane production of embryos in double cross hybrids with those of the respective single cross parents we find that these indices are lower in double cross hybrids. This phenomenon is probably connected with the reduced hybrid vigour of double crosses and confirms the observation of practical plant growing, namely, that they are inferior to single cross hybrids also in productivity.

These data suggest that the value of the shoot/root weight ratio may be considered as an index of heterosis effect.

Shoot/root ratios determined in fresh weight do not differ from those determined on the basis of dry matter ($\chi^2 = 0.20$); thus the ratio can be determined either in fresh or in dried seedlings.

The seedling weight of single and double cross hybrids examined in our experiments exceeded, in every case, that of the parents. No correlation could be found, however, between seedling weight and formasane production. Since overdevelopment of hybrid seedlings showed itself in every case without involving changes in any other physiological index, such as dehydrogenase activity, we think, that the seedling weight in itself does not characterize the extent of heterosis.

REFERENCES

BARKA, T.—ANDERSON, P. J. (1963): Histochemistry. Harper and Row, New York, 296—318.

BARANOVSKY, P. M.—GARMS, F. J.—Барановский, П. М.—Гармс, Ф. Й. (1966): Физиолого-биохимическая природа гетерозиса, как основа разработки методов диагностики подбора пар кукурузы для скрещивания на гетерозис. Гетерозис в растениеводстве ставропол, НИИСХ, 6—15.

DOROVSKAYA, J. F.—Доровская, Й. Ф. (1965): Физиологические свойства межлинейных гибридов кукурузы в связи с их гетерозисом. Достижения биологии в сельскохозяйственном производстве. Москва, Изд. Колос. 17—21.

DIAKONU, P.—Диакону, П. (1963): Некоторые физиологические различия компонентов гибридов кукурузы. (На примере ВИР 25.) Докл. ТСХА, Биология, Земледелие и Растениеводство, **83,** 60—63.

DANIEL MC, R. G.—SARKISSIAN, I. V. (1966): Heterosis: Complementation by mithokondria. Science, **152,** 1640—1642.

EL-ERYANI, A. A.—FLEMING, A. A. (1966): Seedling and biochemical differences within a long-time maize *(Zea mays* L.) inbred. Crop. Sci., **6,** 31—33.

FEDOROV, P. S.—TEPLOVA, E. A.—Федоров, П. С.—Теплова, Е. А. (1962): Биохимическая разнокачественность семян самоопыленных линий кукурузы. Бюллетень Киргизск. Н-и Инст. Земл. **6,** 35—40.

GOLÜNSKAYA, E. L. *et al.*—Голынская, Е. Л. и др. (1965): Физиолого-биохимические особенности вегетативных и генеративных органов кукурузы в связи с гетерозисом. Физиол. Раст. 12. 3. 440—452.

GÁSPÁR, L. (1963): Adatok a hibridvigor élettanához. Kukorica nemesítési és termesztési symposium előadásai (Data on the physiology of hybrid vigour. Lectures delivered at a conference on the breeding and production of maize). Martonvásár, 3—29. Manuscript.

HAGEMAN, R. H.—ZIESERL, J. P.—LENG, E. R. (1962): Levels in nitrate reductase activity in inbred lines and F_1 hybrids in maize. Nature, **197,** 263—265.

IRNAZAROV, J.—KALININ, F. L.—Ирназаров, Й.—Калинин, Ф. Л. (1966): Процессы активации киснуя в эмбриогенези гетерозисных гибрыдов кукурузы та выхидных батькивскых форм. Укр. Бот. Ж., **23,** 23—30.

JÁMBOR, B.—DÉVAY, M. (1959): Növényi dehidrogenáz-rendszerek mérése trifeniltetrazóliumkloriddal (TTC). I. Az inkubációs idő megválasztása (Dehydrogenase systems of plants tested with triphenyl-tetrazolium-chloride (TTC). I. Determination of incubation time). MTA Biol. Csop. Közl., **3,** 401—412.

MOLOTKOVSKY, G. H.—Молотковский, Г. Х. (1966): Полярность и гетерозис у растений. Вестн. Сельскохоз. Науки, 11, 28—34.

SVÁB, J. (1967): Biometriai módszerek a mezőgazdasági kutatásban (Biometrical methods in agricultural research). Mezőgazdasági Kiadó, Budapest.

SCHRADE, L. E.—PETERSON, D. M.—LENG, E. R. (1966): Nitrate reductase activity of maize hybrids and their parental inbreds. Crop Sci., **6,** 169—173.

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CHROMOSOME NUMBERS AND KARYOTYPES IN THE GENERA CROTALARIA AND SESBANIA

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Distinct dissimilarities in karyotypes have been found in three species of *Crotalaria* studied. Five types of chromosomes in *C. rotundicarinata* Baker, four types in *C. retusa* L. and only three types in *C. dissitiflora* Benth. are observed. Lengths of chromosomes in *C. dissitiflora* Benth. were relatively longer than those of *C. retusa* L. and *C. rotundicarinata* Baker. Two pairs of secondary constricted chromosomes in *C. dissitiflora* Benth. and one pair in *C. rotundicarinata* Baker are noted and there are no secondary constricted chromosomes in *C. retusa* L. In *C. retusa* L. five chromosome pairs with median, one each with submedian, sub-terminal and nearly median constriction were found. In *C. rotundicarinata* Baker out of nine constrictions three were subterminal, three sub-median, two median and only one nearly median in position are noted, whereas in *C. dissitiflora* Benth. nine sub-terminal and three submedian in position are observed. Chromosome number 2n = 20 in *C. dissitiflora* Benth. is a new record. In the genus *Sesbania*, five types of chromosome pairs are observed in *S. paludosa* Prain. and only four types in *S. sesban* L. Chromosome length in both species are nearly the same. Both of them have only one pair of secondary constricted chromosomes. In *S. sesban* L. out of seven constrictions, four are sub-terminal, two sub-median and only one median in position, whereas in *S. paludosa* Prain. three are sub-terminal, two sub-median, one nearly median and one median in position. Chromosome number 2n = 12 in *S. paludosa* Prain. is a new record.

Introduction

Crotalaria retusa L. is an erect, robust undershrub of India. It is occasionally cultivated for fibre, which is used in admixture with sun-hemp *(C. juncea* L.) in cordage and canvas. The fibre is tough, but is amenable to improvement, if attention is paid to its cultivation. It is mentioned as a dye plant in East Africa (Wealth of India 1950). *C. rotundicarinata* Baker is a foreign species of South Africa cultivated in the National Botanic Gardens, Kirstenboch, New Lands C.P., S. Africa. *C. dissitiflora* Benth. is a foreign wild species of New South Wales, Australia. *Sesbania sesban* L. *(S. aegyptiaca* Pers.) is an unarmed softwooded perennial shrub, 6—10ft. high with terete, twiggy branches. It is cosmopolitan in the tropics of the old World and often cultivated in European gardens for its bright yellow flowers. It is a good fodder plant, much relished by the livestock in Australia and some parts of the plant are medically used. From the bark coarse fibres are produced. It is an important leguminous plant from the agricultural point of view. In India it is used as hedge as well as green manuring crop.

S. paludosa Prain. is a wild species more robust, unarmed, leaves glabrous, found in India.

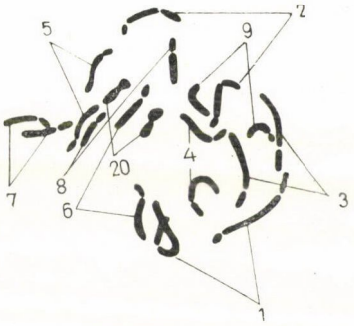


Fig. 1. Showing 20 chromosomes in a root tip cell of *C. dissitiflora*

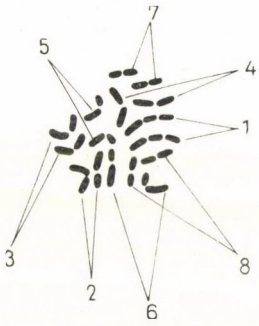


Fig. 2. Metaphase in a root tip cell of *C. rotundicarinata* showing 16 chromosomes

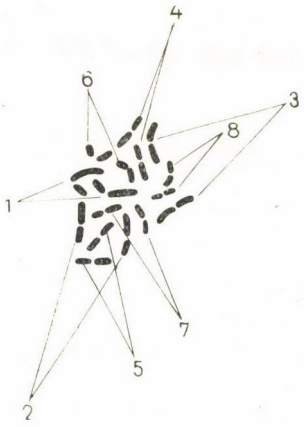


Fig. 3. Metaphase in a root tip cell of *C. retusa* showing 16 chromosomes

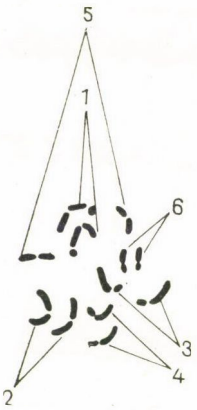


Fig. 4. Metaphase in a root tip cell of *S. paludosa* showing 12 chromosomes

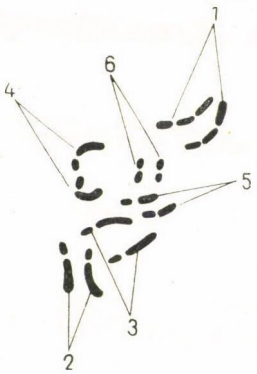


Fig. 5. Metaphase in a root tip cell of *S. sesban* showing 12 chromosomes

Chromosome numbers in several species of these genera were previously reported (DARLINGTON — WYLIE 1955, CHANDRASEKHARAN — PARTHASARATHY 1960).

SRIVASTAVA (1958) observed seven types of chromosomes in somatic metaphases of *C. Brownei* ex Dc. and *C. saltiana* Andr. In the former 1 pair of long chromosomes with submedian constrictions and 3 pairs of medium chromosomes with submedian constrictions are observed. In the latter, 1 pair of long chromosome with submedian constrictions, 2 pairs of median chromosomes with median constrictions and 5 pairs of medium chromosomes with submedian constrictions occur. The pair of large chromosome A is satellited in both the cases but the second pair of SAT-chromosomes is different in the

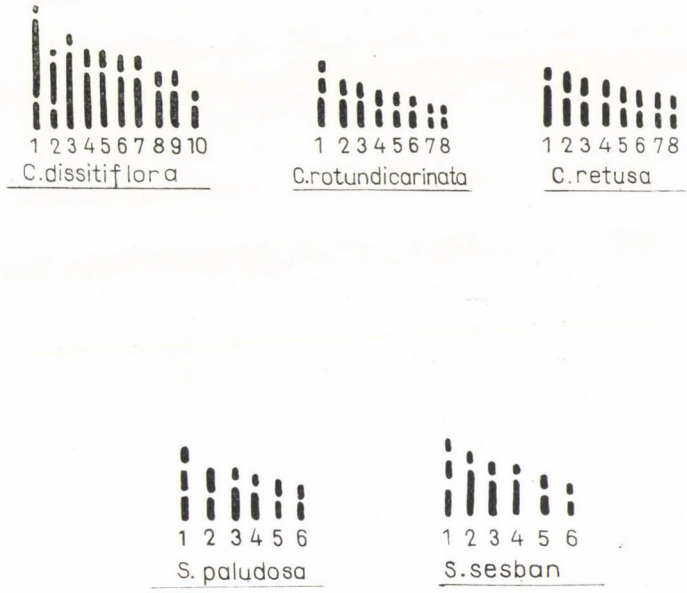


Fig. 6. Idiograms of the haploid set of chromosomes of *C. dissitiflora*, *C. rotundicarinata*, *C. retusa*, *S. paludosa* and *S. sesban*

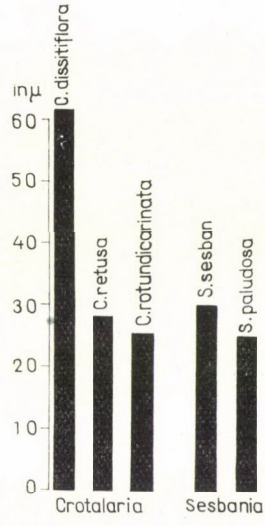


Fig. 7. Histogram showing the amount of chromatin matter in the different species of *Crotalaria* and *Sesbania*

two species being E in *C. Brownei* and the much longer pair C in *C. saltiana*. In *C. Brownei* the duplicated pair in the complement is G., whereas E is duplicated in the other. A critical examination of the idiograms reveals that both of them do not belong to the same species, as suggested previously. Such variations arise due to hybridization between species with distinct karyotypes,

or as a result of non-homologous translocations resulting in the transfer of satellites to different chromosomes. Both phenomena are known to be operative in plants and are of considerable significance in the course of evolution and origin of new species. Besides, chances of spontaneous breakage and reunions resulting in the alteration of gross chromosome morphology, though rare, cannot be ruled out altogether. In 1960 DATTA—GANGULY (1967) obtained five types of chromosomes in *C. juncea* L. and six types of chromosomes in *C. anagyroides* Retz. and *C. sericea* H.B.K. DATTA—BISWAS (1963) observed the karyotypes of *C. saltiana* (= *C. striata* L.) and *C. verrucosa* L. and recorded six types of chromosomes and differed from the observations of SRIVASTAVA (1958) in case of *C. saltiana*. Somatic chromosome number (2n = 16) in the case of *C. ferruginea* Grah. was recorded for the first time.

GHOSHAL (1962) first reported the diploid chromosome number of *C. rotundicarinata* as 2n = 16. DATTA—GHOSHAL (1968) also worked out the karyotypes of *C. capensis* Jacq. and *C. ferruginea* Grah. and recorded five types of chromosomes but they observed four types of chromosomes in case of *C. mysorensis* Roth.

TURNER—FEARING (1959) reported the diploid chromosome numbers of *C. erecta* Schinz., *C. laburnifolia* L. and *C. mesopontica* Taub. From their drawings it seems that *C. erecta* has 12 chromosomes with median centromeres and 4 chromosomes with submedian centromeres, that *C. laburnifolia* L. has 8 chromosomes with primary and secondary constrictions, 4 with median constrictions and 4 with submedian constrictions and that *C. virgulata* Klotzsch has 2 chromosomes with subterminal constrictions and 12 chromosomes with median centromeres and 2 chromosomes with submedian constrictions. Their drawings did not give any clear karyotypic details and these are somehow discerned.

DANA—DATTA (1961) first reported the karyotypes of *Sesbania aculeata* Per. (4n race) and found four types of chromosomes, whereas in *S. speciosa* Taub. ex Engler. (2n race) they observed three types.

Material and Method

Seeds of different species mentioned below were obtained from:

C. retusa L.	V. Dnyansagar, Vidharbha Mahavidyalaya, Amravati.
C. rotundicarinata Baker	Director, National Botanic Gardens, Kirstenboch, Newlands. C. P., S. Africa.
C, dissitiflora Benth.	Davis, New South Wales, Australia.
S. sesban L. and *S. paludosa* Prain.	Forest Botanist, Forest Research Inst., Dehra Dun, U. P.

Seeds of different species of Crotalaria and *Sesbania* were first treated with conc. H_2SO_4 for about 10—15 mins., then thoroughly washed in running water before putting them on moist filter papers in petri dishes in order to germinate.

For karyotype study, young and healthy root tips were fixed at different periods between 9 and 11 a. m. During this period rapid cell divisions were found to occur. Root tips were pretreated with saturated solution of Aesculin for 30—45 mins. at 8°C—10°C. They were then fixed in acetic-alcohol (1:2) for 30 mins. Afterwards they were gently heated for

Table 1

Measurements of somatic chromosomes of different Crotalaria species

Species	Types	Chromosome pairs	Length in μ	Av. length in μ	R. length	F%	T.F.%	Centromere	No. of secondary constricted chromosomes
C. retusa L.	A	1	4.50		100	25		st	nil
$ABCD_5$	B	2	4.00		88.8	40		sm	
	C	3	4.00		88.8	45	$\frac{12.5\times100}{28}$	nm	
	D	4	3.50		77.7	50		m	
		5	3.50	3.50	77.7	50		m	
		6	3.00		66.6	50	$= 44.64$	m	
		7	3.00		66.6	50		m	
		8	2.50		55.5	50		m	
	2n =	16	28.00				5m, 1nm, 1sm, 1st		
C. rotundi-	A	1	4.50		100	40		st, sm	1
carinata	B	2	3.50		77.7	40		sm	
Baker		3	3.50		77.7	40	$\frac{10.7\times100}{25.45}$	sm	
$AB_2CD_2E_2$	C	4	3.45		76.5	45		nm	
	D	5	3.00	3.18	66.6	33		st	
		6	3.00		66.6	33	$= 42$	st	
	E	7	2.25		50.0	50		m	
		8	2.25		50.0	50		m	
	2n =	16	25.45				3st, 2sm, 2m, 1nm		
C. dissitiflora	A	1	11.25		100	25		sm, st	2
Benth.		2	6.75		60.0	25		sm, st	
A_2B_7C	B	3	9.00		80.0	25		st	
		4	5.62	6.148	80.0	25	$\frac{15.16\times100}{61.48}$	st	
		5	5.62		50.0	25		st	
		6	5.62		50.0	25		st	
		7	5.62		50.0	25	$= 24.66$	st	
		8	4.50		40.0	25		st	
		9	4.50		40.0	25		st	
	C	10	3.00		26.6	33		sm	
	2n =	20	61.48				7st, 3sm		

a few seconds in a mixture of 2 per cent aceto-orcein and NHCl in the proportion of 9 : 1 and kept as such for half an hour. Finally tips were squashed in 1 per cent aceto-orcein solution on clean slides applying uniform pressure over cover glasses. Excess of stain was removed by blotting with filter paper and cover glass was sealed with paraffin. The slide was then examined critically under the microscope. Camera lucida drawings were made.

Results

Diploid chromosome numbers in *Sesbania paludosa* Prain. and *Crotalaria dissitiflora* Benth. are found to be 2n = 12 and 20 respectively and are reported for the first time.

Karyotypic studies have been carried out on three species of *Crotalaria*, namely *C. retusa* L., *C. rotundicarinata* Baker and *C. dissitiflora* Benth. and

Table 2

Measurements of somatic chromosomes of Sesbania species

Species	Types	Chromosome pairs	Length in μ	Av. length in μ	R. length	F%	T.F.%	Centromere	No. of sec. constricted chromosomes
S. sesban L.	A	1	6.00		100	40		st, sm	1
AB_3CD	B	2	5.75		95.83	20	$\frac{9.75 \times 100}{29.25}$	st	
		3	5.50	4.87	91.66	25		st	
		4	5.50		83.33	25		st	
	C	5	4.00		66.66	40	$= 33.33$	sm	
	D	6	3.00		50.00	50		m	
	2n =	12	29.25				4st, sm, 1m		
S. paludosa	A	1	6.00		100	30		sm, st	1
Prain.	B	2	4.50		75.0	45	$\frac{9.22 \times 100}{25.02}$	nm	
ABC_2DE	C	3	4.12	4.17	68.6	25		st	
		4	3.45		57.4	33		st	
	D	5	3.50		85.31	50	$= 36.85$	m	
	E	6	3.45		57.4	40		sm	
	2n =	12	25.02				2st, 2sm, 1nm, 1m		

Relative length (R. Length) is used to represent the ratio in percentage of the length of the individual chromosome to that of the largest one. F per cent represents the percentage of the short arm length to the entire chromosome length. TF per cent represents the ratio in percentage of the total sum of short arm length to the total sum of chromosome length. (nm = nearly median; m = median; sm = sub-median and st = sub-terminal.)

two species of *Sesbania*, namely *S. paludosa* Prain. and *S. sesban* L. (= *S. aegyptiaca* Pers.).

The detailed analysis regarding the structure of chromosomes, position of centromeres etc. are recorded in Tables 1 and 2.

Discussion

Although the karyotypic analyses of *Crotalaria rotundicarinata* Baker and *Crotalaria retusa* L. show a considerable amount of differences but their somatic chromosome numbers are reported to be 2n = 16.

With this similarity in chromosome number there is also a certain degree of similarity between the two in respect of the size of the very long chromosome type "A", but there the main difference is that in *C. rotundicarinata* Baker, the chromosome type A is provided with a secondary constriction, which is entirely absent in that of *C. retusa* L. Besides this, there exist other differences also. For example, the karyotype of *C. retusa* L. mainly consists of five pairs of median and one pair of each with sub-terminal, sub-median and nearly median constricted chromosomes, whereas *C. rotundicarinata* Baker shows

a majority of sub-terminal, sub-median and nearly median constricted chromosomes and very low median constricted chromosomes.

These differences distinctly indicate the importance of the structural alteration of chromosomes in the evolution of species.

In case of *C. dissitiflora* Benth., a foreign species of New South Wales the chromosome number is reported to be $2n = 20$ for the first time. Besides this, karyotype also varies and is distinct from those of the other two species studied. Here the chromosomes are extremely long and almost all of them are provided with subterminally placed centromeres, except in type C, where it is submedianly placed. In type A two pairs of secondary constricted chromosomes are recorded as compared to one pair of *C. rotundicarinata* Baker. Here D and E types of chromosomes are entirely absent.

Therefore, the numerical and morphological differentiations and the structural changes of chromosomes are considered to be the basis of specification of this genus (TAKEMOTO 1962).

According to LEVITSKY (1931), karyotypes can be broadly classified into two groups — 1. Symmetrical with similar chromosomes and median constrictions and 2. asymmetrical — with dissimilar chromosomes mainly with sub-terminal, terminal and sub-median centromere; the former type is supposed to be the most primitive type and the latter type is considered to be more advanced.

From the above facts it is suggested that *C. dissitiflora* Benth. is much more advanced than the other two species, whereas *C. retusa* lies towards a more primitive side than *C. rotundicarinata* Baker, which is slightly advanced in the course of evolution.

Chromosome numbers, reported so far for the genus *Crotalaria* (DARLINGTON—WYLIE 1955, CHANDRASEKHARAN—PARTHASARATHY 1960, etc.) show that the genus is monobasic with 8 as the basic number, though variations were also reported from time to time (ATCHINSON 1950, ROY—SINHA 1959, DATTA—GHOSHAL 1968). The chromosome number in *C. dissitiflora* Benth. ($2n = 20$) may be a genetic hyperploid variant of a species with $n = 8$. The chromosome number of this species from different sources should be studied, as the basic number in this genus has been found to be $n = 8$ (ROY—SINHA 1959).

In the karyotypic studies of *Sesbania*, not much interspecific differences were noted in relation to chromosome length and structure but the main difference was with the types of chromosomes. In *S. sesban* L. only four types of chromosomes were recorded as compared to five types of *S. paludosa* Prain. (DANA—DATTA 1961).

The number of median and submedian constricted chromosomes is the same in both the species and the number of subterminal constricted chromosomes is nearly equal, which suggests that both the species are in the same position between primitive and advanced types.

REFERENCES

ATCHISON, E. (1950): Studies in the *Leguminosae*. V. Cytological observations on *Crotalaria*. Jour. Elisha Mitchell Sci. Soc., **65,** 70—75.

CHANDRASEKHARAN, S. N.—PARTHASARATHY, S. V. (1960): Cytogenetics and plant breeding. P. Varadachary et Co., Madras., 559.

DANA, S.K.—DATTA, R.M. (1961): Comparative cytological studies of the pollen and pollen tube in diploid and tetraploid species of *Sesbania*. New Phytol., **60,** 295—311.

DARLINGTON, C.D.—WYLIE, A.P. (1955): Chromosome atlas of flowering plants. 166—167.

DATTA, R.M.—BISWAS, P.K. (1963)- Karyotypic study in the genus *Crotalaria*. II. Caryologia, **16,** 701—705.

DATTA, R.M.—GANGULY, P.K. (1967): Karyotypic study in the genus *Crotalaria*. I. Broteria., **36,** 39—45.

DATTA, R.M.—GHOSHAL, K.K. (1968): Karyotypic studies in the genus *Crotalaria*. III. Zeit. f. Bot. (In press.)

GHOSHAL, K.K. (1962): Chromosome number of *Crotalaria rotundicarinata* E. G. Baker, a wild species from South Africa. Sc. et Cult., **28,** 378.

LEVITSKY, G.A. (1931): The morphology of chromosomes. Bull. Appl. Bot., **27,** 19—174.

RAO, Y.S. (1943): Some chromosome numbers in the genus *Crotalaria*. Ind. Jour. Genet. et Pl. Br., **3,** 64—66.

ROY, R.P.—SINHA, R.P. (1959): Meiotic studies in *Crotalaria sericea*. Retz. and the basic number in the genus *Crotalaria*. Cur. Sci., **28,** 253.

SRIVASTAVA, M.G. (1958): Cyto-taxonomic position of *Crotalaria brownei* Bert. ex. Dc. Cytol., **23,** 193—199.

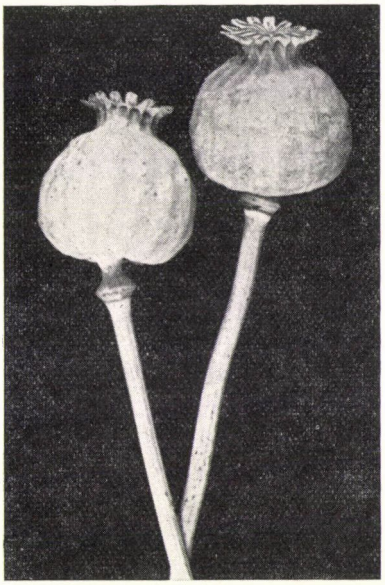
TAKEMOTO, T. (1962): Cytological studies in *Taraxacum* and *Ixeris*. II. Some Japanese races of the *Ixeris dentata* complex. Biol. Jour. of Okayama Univ., **8,** 59—89.

TURNER, B.L.—FEARING, O.S. (1959): Chromosome numbers in the Leguminosae. II. African species, including phylogenetic interpretations. Amer. J. Bot., **46,** 49—57.

C.S.I.R. Publication (1950): Wealth of India, **2,** 382.

Acta Agronomica Academiae Scientiarum Hungaricae, Tomus 19 (3—4), pp. 351—412 (1970)

VARIA



INDEHISCENT CAPSULED BLUE POPPY OF HATVAN

Taxonomical place: Papaver somniferum L. var. *caesium* DC.

Origin: from a farm variety by individual selection.

Beginning of breeding: 1920, Hatvan.

State qualification: state registered improved variety, 1951; first accepted in 1939, first registered in 1939.

Breeder: †Ödön Legány (Hatvan); maintainer: Sándor Mórász (Kompolt).

General characterization: not too demanding, resistant, high and reliably yielding indehiscent capsuled blue poppy variety with satisfactory morphine content (KAPÁS *et al.* 1965).

Morphological description:

Root system: The thick spindle-shaped root penetrates to a depth of 40—80 cm into the soil where, by branching off abundantly, it develops a strong root system.

Shoot system: develops a medium high stalk inclined to branching off; number of lateral shoots 3—5, plant height 110—135 cm.

Stem: medium firm, cylindrical with waxen surface; stability is 3.92 (perfect stability: 5) (SVÁB—BAKOS—KISS—IVÁNYI 1968).

Foliage: Medium large, oblong ellyptical, slightly dentate, hairy, ash-green leaves in a scattered position; number of leaves on fully developed plants 23 with a $^{2}/_{5}$ divergency (SÁRKÁNY—SÁRKÁNY-KISS—DÁNOS—FARKAS-RIEDEL 1959).

Flowers: flower buds are of broad egg-shape, sharp at the tip. Petals of open flowers are white with a light violet spot at the base; dimension of petals: 8.0—10.0 cm.

Fruit: flattened pear-shaped capsule, with a retreating collar part at the base and cylindrical contraction at the top. Fruit stem slightly hairy. Stylar end flatly

arched, somewhat sunken in the centre. Number of stigmulae an average of 14, cut off at the edge, irregularly dentate and widening. Capsule closed, brownish-grey when ripe. Each plant develops 3—5 capsules. Dry capsules contain an average of 0.456 (ranging from 0.439 to 0.473) per cent morphine base; average quantity of minor alkaloids: codeine 0.350, tebaine 0.267, narcotine 0.135, papaverine 0.092 per mille. Average capsule height (that is, the level of 90 per cent of capsules between the stylar end of the uppermost capsule and the stem end of the lowest capsule) 54.7 cm (SVÁB *et al.* 1968). The shape of capsules is not uniform in the population.

Seed: pleasant dark blue colour; thousand-grain-weight 0.43—0.45 g. Fatty oil content of seeds an average of 46.1 per cent (ranging between 45.2 and 46.6) (IVÁNYI 1967).

Biological characters:

Germination: cardinal points: minimum +3 °C, optimum 20 °C, maximum 35 °C (SZABÓ non publ.).

Vegetation period: medium long, 120—130 days (sown in the middle of February). Requires early sowing.

Water requirement: moderately sensitive to drought; during the vegetation period it requires about 250—260 mm precipitation (MÁNDY non publ.).

Resistance to disease: resistant (KAPÁS *et al.* 1965).

Farm technology requirement:

Seeding: the earlier the better (in February already!), not deep if possible (KAPÁS *et al.* 1965).

Soil requirement: nothing particular.

Productivity: average yield of empty capsules 667 kg/ha, seed production 704 kg/ha (IVÁNYI 1967). Productivity is good.

Region of cultivation: the whole area of Hungary; it is, however, especially successfully grown in Transdanubia and the northern counties (KAPÁS *et al.* 1965).

*

Prepared at the National Institute of Agrobotany, Tápiószele.

GY. MÁNDY

REFERENCES

IVÁNYI, S. (1967): Adatok néhány mákfajta értékbírálatához (Contribution to the evaluation of some poppy varieties). Nemesített Növényfajtákkal Végzett Országos Fajtakísérletek Eredményei 1966. OMFTMI., Budapest, 235—248.

KAPÁS, S. *et al.* (1965): Nemesített növényfajtáink (Improved Hungarian plant varieties). Mezőgazdasági Kiadó, Budapest.

SÁRKÁNY, S. (1960): A mák rendszertani viszonyai és a fajon belüli egységek értékelése (Taxonomic relations of poppy and evaluation of units within the species). In: BARTOS—MÓRÁSZ—SÁRKÁNY—UNK: A mák és termesztése (Poppy and its production). Mezőgazdasági Kiadó, Budapest, 28—38.

SÁRKÁNY, S.—SÁRKÁNY-KISS, I.—DÁNOS, B.—FARKAS-RIEDEL, L. (1959): Studien über *Papaver somniferum* L. und Selektionsversuche von Mohnsorten mit größerer Leistungsfähigkeit für Morphin- und Samenertrag. Acta Botanica Acad. Sci. Hung., **5**, 97—202.

SVÁB, J.—BAKOS, ZS.—KISS, T.—IVÁNYI, S. (1968): Rostlen-, rostkender- és mákfajták értékelési módszere összesített gazdasági értékmutatóval (Method of evaluating fibre flax, fibre hemp and poppy varieties by using global farm indices). Nemesített Növényfajtákkal Végzett Országos Fajtakísérletek Eredményei 1967. OMFTMI., Budapest, 83—92.

DEVELOPMENT OF THE PISTIL IN DIPSACUS SILVESTRIS L.

In the course of studies performed, the development of the pistil types considered as transitions between superior and inferior pistils was investigated. Results had already been obtained in this respect; e.g. pistils of *Syringa vulgaris* L., *Ligustrum vulgare* L. and *Salvia nemorosa* L. show an inferior character at the beginning of their development and become superior only later (GRACZA 1968, SZABÓ—BORBÁS—GRACZA 1969). In the family *Dipsacaceae* the investigations into the development of the flower included the inferior character of the pistil as well; its development was, however, described by some as appendicular and by others as axial (BUCHENAN 1854, PAYER 1857, VAN TIEGHEM 1909, FODOR 1910, SZABÓ 1918, 1922, GOEBEL 1923).

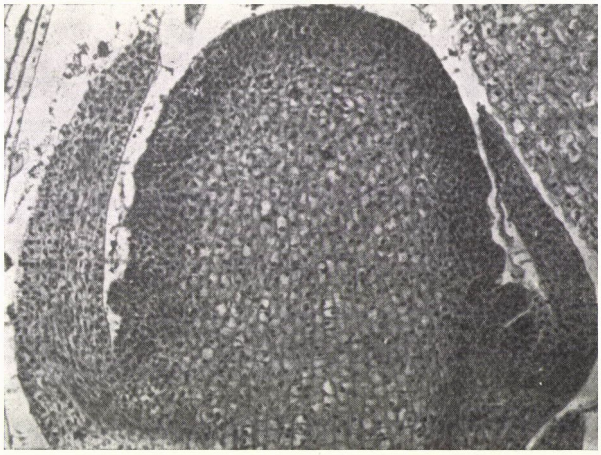


Fig. 1. Developing inflorescence of *Dipsacus silvestris* L. with the differentiating protuberances of flowers (obj. 10×, oc. 2.5×)

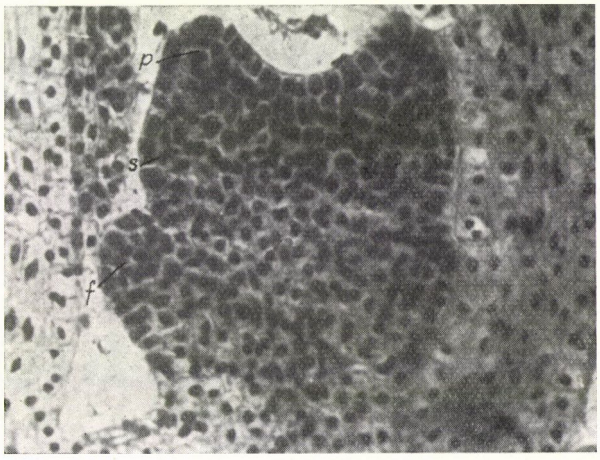


Fig. 2. Young flower primordium with the differentiating protuberances of hypsophylls (f) and initiating calyx (s) and petal primordia (p)

Fig. 3. Part of a young inflorescence. Androecium is differentiating in flower primordia (obj. 10×, oc. 2.5×)

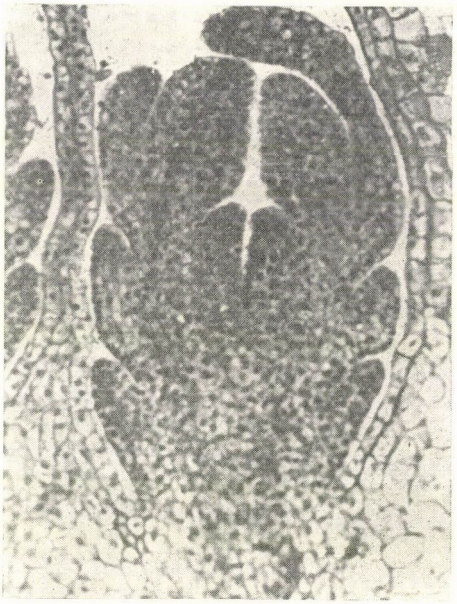


Fig. 4. Flower primordium at a later stage, with differentiating pistil primordia of superior position (obj. 20×, oc. 2.5×)

Fig. 5. Fully developed flower with a pistil that has become of inferior position (obj. 10×, oc. 2.5×)

Flower primordia, developing along the parastiches located slantwise in an acropetal order on the conic inflorescence primordium, are of oblong semi-spherical shape (Fig. 1). The first signs of differentiation appear in the lateral part of the flower primordium, in the second tunic layer; along the median and transversal planes four protuberances — the initial hypsophylls — develop, congenitally grown already together; thus a uniform tissue ring — involucellum — is formed in the central part of the initial flower, which subsequently rises and becomes flat due to an intensive cell division occurring in the second tunic layer, in the periferal section of the upper semi-spherical part of the initial flower. Somewhat later, above the hypsophylls, in a position alternating with them four calyx primordia differentiate (Fig. 2). At the same time, in the periferal part of the flattened flower primordium, in the median and transversal planes four corolla initials appear. After having developed corolla initials grow together at the edges by connation, and initial stamina developing along the diagonal planes soon grow at their bases to the primordial corolla tube by adnation.

Simultaneously with the rising of the two carpel primordia initiated in the median plane (Fig. 3), cells around the hypsophylls begin to stable, while the zone where the floral leaves rise, cells excell by their large nuclei and good stainability. The primordial carpel is at that stage in a definite superior position compared to the place the other floral leaves rise from. Pistil, stamen and corolla primordia grow together by adnation at an early stage (Fig. 4). Through the activity of a meristemic zone persisting for a long time at the basal part of the floral leaves, corolla and androecium considerably elongate and grow parallel with the developing gynoecium, with the result of the ovary part getting gradually below the level of the floral leaves, that is in an inferior position (Fig. 5). This state comes about by the end of flower development. The inferior position of the pistil — as considered on the basis of its development — is only apparent (appendicular). This fact is proved also by the bundle system of the flower. In the tissue zone formed by the floral leaves encircling the ovary, there are eight bundles. Four of them — in the diagonal planes — are the joint bundles of calyx and stamina, while in the transversal and median planes four petal bundles are found.

To sum up what have been said: on the basis of the circumstances of floral development and vascular bundles passing through the flower, the pistil of *Dipsacus silvestris* L. can be considered a type of apparent inferior position.

*

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REFERENCES

Buchenau, Fr. (1854): Über die Blütenentwicklung einiger Dipsacaceen, Valerianaceen und Compositen. Abhandlungen der Schenkenberg Gesel. 106.

Fodor, F. (1910): Adatok a *Cephalaria*-fajok hisztológiájának ismeretéhez (Data on the histology of *Cephalaria* species). Botanikai Közl., 4.

Goebel, K. (1923): Organographie der Pflanzen. Gustav Fischer Verlag, Jena.

Gracza, P. (1968): The development of the pistil in *Syringa vulgaris* L. Acta Agronomica Acad. Sci. Hung., **16,** 439—442.

Payer, J. B. (1857): Traité organogenie de la fleur. Librairie de Victor Masson, Paris.

Szabó, Z. (1918): A *Dipsacaceá*k virágzatának fejlődéstani értelmezése (Evolutionary interpretation of inflorescence in *Dipsacaceae).* Dunántúli Könyvkiadó és Nyomda, Pécs.

Szabó, Z. (1922): A *Cephalariá*k virágának fejlődése (Flower development in *Cephalaria* species). Szent István Akadémia Értesítője, **1,** 40—50.

Szabó, M.—Borbás, P.—Gracza, P. (1969): The development of the pistil in *Ligustrum vulgare* L. Acta Agronomica Acad. Sci. Hung., **18,** 449—452.

Van Tieghem, Ph. (1909): Remarques sur les *Dipsacacees.* Ann. des Sc. Nat. 7 Ser. Botanique X. 148.

DATA ON THE DIAPAUSE OF CEUTHORRHYNCHUS MACULA-ALBA HERBST. (COLEOPTERA: CURCULIONIDAE)

C. macula-alba is a homodynamous insect. Having transformed into an imago in spring it stays at rest (diapause) until the next spring in an underground hole prepared before pupation (SZELÉNYI 1935, 1939, ZSOÁR 1950, NOLTE 1952, MANOLACHE—IGNATESCU—KOLOSY—GHIUTA—TITZ 1961, SÁRINGER—ZSOÁR 1963 and SÁRINGER 1964). It means that it leaves its hibernaculum only after $7—7^1/_2$ months of rest. A diapause of such character is called true or obligatory diapause.

Investigations have been made in order to find out how long imagos have to stay at rest to be able to start their active life functions again.

For the purpose of examination poppy capsules infected by larvae were placed in large earthen vessels (of 25 cm diameter and 40 cm height) half filled with soil. The culture pots were sunk into the ground in the field. Larvae leaving the capsules penetrated into the soil of the pot, where they prepared holes, then pupated and transformed into imagos. Each culture pot contained 35—40 imagos. In the middle of September, 10 culture pots per treatment were removed from the ground and placed under the following conditions:

a) greenhouse throughout the whole winter (temperature: maximum +31 °C, minimum +3 °C),

b) thermostat at 28 °C,

c) thermostat at 23 °C,

d) thermostat at 18 °C,

e) control: field plot.

Animals kept in greenhouses heated throughout the whole winter began to appear on the surface in the middle of March. $1^1/_2—2$ weeks later they peeled covetously the leaves of young poppy plants grown in the greenhouse, then mated but did not lay eggs.

Imagos kept in a thermostat at a temperature of 28 °C emerged first on the last days of April. Emerging was protracted and irregular, imagos sporadically appeared even at the end of the summer; moreover, when culture pots were sifted at the beginning of October, several living imagos were found at rest in their holes. It must be noted that the highest percentage mortality during the diapause occurred at 28 °C. Imagos emerged, fed slowly and did not lay eggs.

Imagos kept at 23 and 18 °C, respectively, emerged first in early June. Emerging lasted until October and was irregular and sporadical. Imagos behaved the same way as mentioned in the case of those kept at 28 °C. These imagos did not lay eggs either.

In the culture pots dug in the field the first imagos emerged on 28th April and the last ones on 17th July. 50 per cent of the imagos appeared on the surface by 11th June. Imagos fed normally, mated and layed eggs.

Above data show that though the state of rest of poppy-weevils comes to an end even at temperatures above 0 °C, the most important criterion of activity: egg laying takes place only after a state of rest of some duration at temperatures below 0 °C.

The question of how long a resting period is required for the activization (mowing, feeding, mating and egg laying) to start, was decided by placing every month a part of the field cultures under optimum conditions (23 °C, and daily 16 hours illumination). According to the examinations performed imagos emerged after $2^1/_2—3$ weeks only in culture pots lifted from the end of January on; these displayed a normal activity and layed eggs. This means that under field conditions a resting period of at least 5 months is required for the imagos to start activities again.

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REFERENCES

MANOLACHE, F.—IGNATESCU, I.—KOLOSY, E.—GHIUTA, M.—TITZ, M. (1961): Recherches sur la biologie et la lutte contre le charançon des capsules de pavot *(Ceuthorrhynchus macula-alba* Herbst.). Int. Centr. Cercet. Agricol. Anale, Bucuresti, **29,** C, 163—176.
NOLTE, H. W. (1952): Alte und neue Mohnschädlinge. Deutsche Landwirtschaft, **7,** 1—4.
SÁRINGER, GY. (1964): Der Wintermohn und die Mohnschädlinge. Ann. Inst. Prot. Plant. Hung., **9,** 185—194.
SÁRINGER, GY.—ZSOÁR, K. (1963): A máktok-ormányos elleni védekezés (Poppy-weevil control). Magyar Mezőgazdaság, **25,** 12—13.
SZELÉNYI, G. (1935): Some observations from the life history of the poppy-weevil, *Ceuthorrhynchus macula-alba* Herbst. Kísérletügyi Közlemények, **38,** 217—224.
SZELÉNYI, G. (1939): Die Schädlinge des Ölmohns in Ungarn. Verh. 7. Intern. Kongr. Entom., Berlin, **4,** 2625—2639.
ZSOÁR, K. [1950): Adatok a máktokbarkó *(Ceuthorrhynchus macula-alba* Herbst.) biológiájához (Data on the biology of poppy-weevil *(Ceuthorrhynchus macula-alba* Herbst.)]. Agrártud. Egyet. Mezőgazd. Kar Évkönyve, **1,** 130—136.

DEVELOPMENT OF SPRUCE INFLORESCENCE

It is well known that the spruce, and generally every member of the *Picea* genus, live in those regions of the northern hemisphere which are at least periodically rich in precipitation. It makes no difference whether precipitation appears in the form of rainfall or dew, the plant is forced to protect its most sensitive parts — the tender embryonic life — against moisture. For this purpose it developed millions of years ago already the movable tiles. The cone scales are arranged above each other like roofing tiles and fit tightly together, more precisely: roofing tiles provide shelter from moisture nearly as perfectly as the cone scales do. Female flowers are found on the upper part of the crown of fully developed plants. In warm spring weather, however, the pollens are able to fly up to the female flowers, which are high in the crown, on the uppermost branches. At first sight female flowers differ from the future cone only in size and colour. In the first phase of their life, after casting off the raments, that is at the moment of birth (Figs. 1—4) they differ — among others — from the mature cone in their upright, candle-like position, which is heliotropic. In this case it is a matter of true and positive heliotropism, since, if shoots bearing the flowers are turned in any direction, female flowers will rise again in a direction opposite to gravitation.

In the first stage of development the scales of female flowers are closed towards the apex if the air is very humid, otherwise the scales open in a short time and the flowers assume a shape shown in Figs. 5 and 6. In this phase of development the scales always react to humidity by closing towards the apex. Thus, before fertilization the closing of the scales takes place according to Fig. 7. If, however, a warm, dry weather sets in, the scales curve in a few days (2—5 days depending on the weather), and form horizontal funnels in order to be able to receive the pollen. (Fig. 8.) We almost might speak of "pollen traps". This phase of flowering also lasts only for a short time, generally for 2—4 days.

After the fertilization the scales gradually close, but now towards the base. This phase is shown by Figs. 9 and 10. At the same time the flower spindle begins to elongate, the scales become purple, although at the moment of unfolding they are usually light yellowish green. Fig. 11 shows two cones on the same branchlet in developmental stages described above. Differences in size, position of scales and colour are appreciable. In the subsequent period the young cone continues to elongate and becomes slimmer, as the scales begin to close tightly (Figs. 12 and 13). They must protect the tender embryos against unfavourable external influences. This state of the cone lasts for a longer time, generally for 10—20 days, and during this period the cones change colour again becoming ivy green.

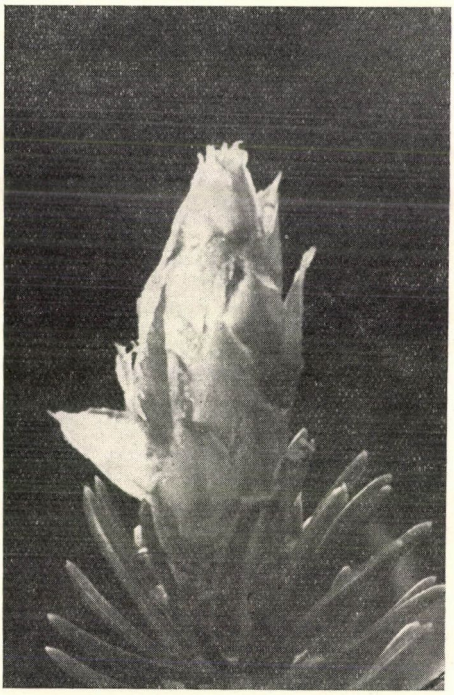

Fig. 1. The female flower bud has elongated and begins to burst

Fig. 2. The flower begins the process of "undressing" by opening the cover scales

Fig. 3. Through the intensive opening of middle scales the flower casts off the raments

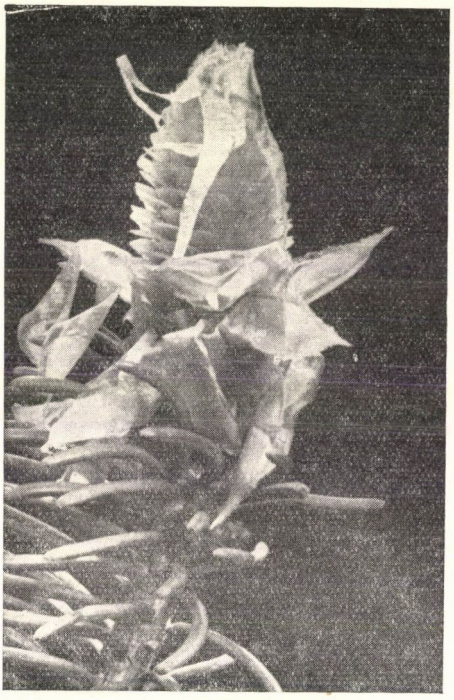

Fig. 4. The same flower in the next morning

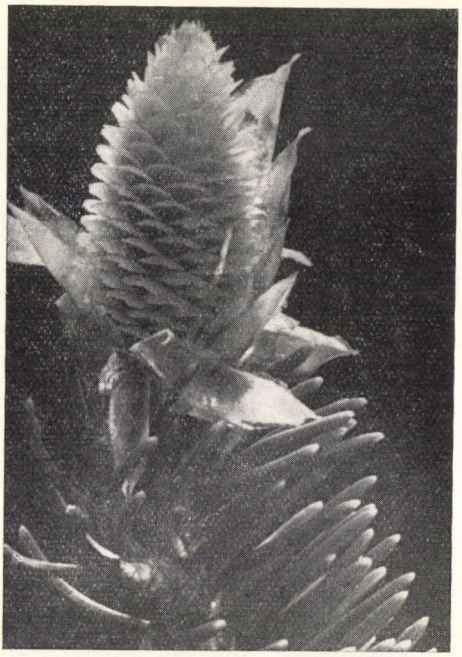

Fig. 5. Under the influence of dry, warm spring weather the scales begin to curl in horizontal level too

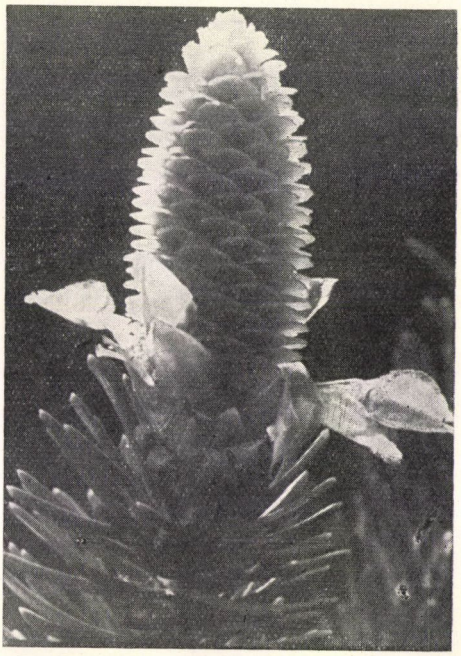

Fig. 6. The same flower 48 hours later

Fig. 7. As a reaction to humidity the scales close towards the apex of the spindle

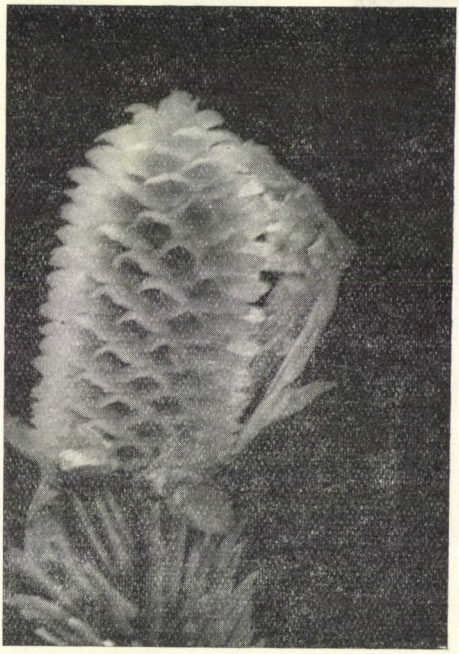

Fig. 8. Flowers ready to receive pollen

Fig. 9. After fertilization the scales begin to close towards the base of the spindle

Fig. 10. The process of closing in progress

Fig. 11. There are flowers in different stages of development on the same shoot

Fig. 12. Scales elongate and the cone spindle grows as well

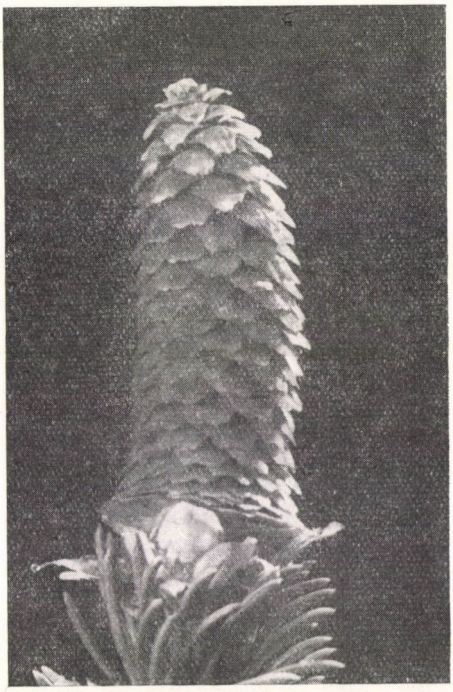

Fig. 13. Scales begin to close tightly

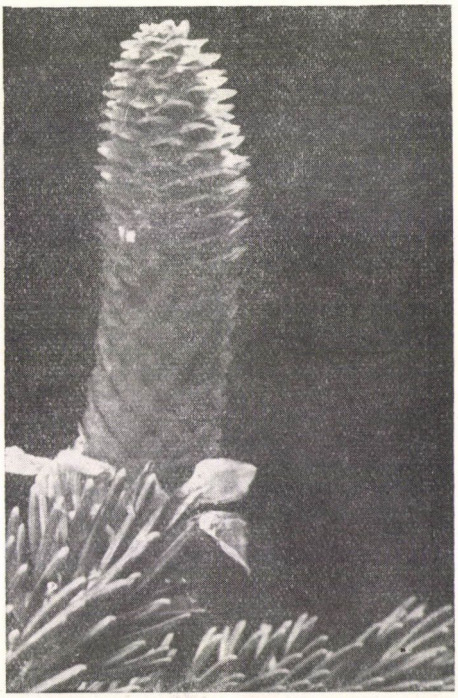

Fig. 14. At the beginning of May the closing direction of scales changes to the opposite

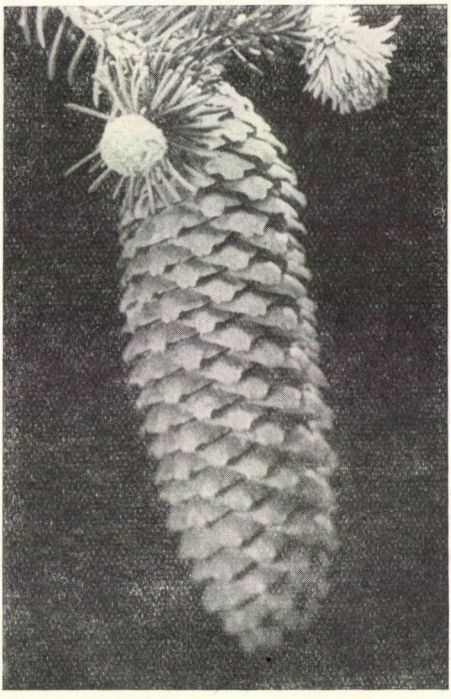

Fig. 15. The mature cone

Then an unexpected thing happens. Under the climatic conditions of Hungary about the 8—12th May the scales of the cones begin to close in the opposite direction, as shown by Fig. 14. The process starts at the base of the spindle and proceeeds towards the apex relatively very quickly, for it is completed in 3 days. After that the cone completely looses its positure strength and suddenly (within a few hours) — by its own weight — gets into a hanging position characteristic of spruce cones (Fig. 15). It remains in this position till autumn when seeds become mature, while its colour changes to brown.

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REFERENCES

FEHÉR, D.—MÁGÓCSY-DIETZ, S. (1931): Erdészeti növénytan (Botany of forestry). III, 17.
PAPP, B.—VARGA, G. (1954): Erdészeti termőhely és növényismeret (Study of forest sites and plants). 192.

THE PRESENT STATE OF RADIOCARBON CHRONOLOGY

Ninety per cent of Hungary's agriculturally exploited area consist of deeply indented Quaternary deposits. A complex geological knowledge of these formations is of basic importance for agricultural practice in respect of not only the subsurface but the entirety of the layers (e.g. water drawing, construction of irrigation systems, examination of soil formation etc.). Since the beginning of the century the various branches of research in this field have developed to such an extent that by now we can speak of a Quaternary research complex. All this stands, however, besides Hungary with equal validity for all glacial and periglacial belts (Europe, Asia, and a great part of North America).

The solution of the problems of absolute and relative chronology forms, among others, the essence of these investigations. In this domain, a device of great importance was supplied: the C^{14} or radiocarbon method. In little less than 10 years this method was brought to such perfection that it was possible to extend its range from 20 000 to 70 000 years (TAUBER 1965). Today, all over the world, more than 30 laboratories carry out such investigations and have produced directly or indirectly thousands of absolute age determinations with respect to the Quaternary. All these results have considerably altered our former knowledge of the absolute and relative chronology of the Quaternary. Meanwhile, however, a great number of problems and contradictions which cannot be discussed in detail in this paper, have arisen so that it seems opportune to draw an unbiassed critical comparison and to give a general evaluation of the results obtained so far. Therefore, in the following, I wish to summarize briefly some of the more significant published data and comparisons, particularly with regard to the Pleistocene, and to draw a few basic conclusions.

According to Dücker, the earliest Weichselian soil in Germany is 46 000 years old, and its is followed by soils 44 700 and 32 000 years old. He suggests a division of the Weichselian into Ana-, Meta- and Kataphases (DÜCKER 1961a, 1961b). According to Ebers, the Laufen interstadial begins around 44 000 (EBERS 1961) and is the only reliable interstadial (Göttweig) also on the basis of the Hörmating profile (EBERS 1964). In Austria, the beginning of the Weichselian is put at 70 000, that of the Fellabrunn complex to 40 000 (FELGENHAUER—FINK—VRIES 1959). Fink insists on a uniform Würm (cf. POPOV in: FIRBAS—FRENZEL 1960 and BÜDEL in: FRENZEL 1962) and accuses Gross of having caused the confusion by publishing compiled works through which a dangerous deviation was created. It is, in all likelihood, the excessive dispersion of data which induced him to such strong criticism. As for the rest he dates the Göttweig at over 54 000, the Stillfried A level at over 52 000, the Stillfried B level, how-

ever, at 28 000 years (FINK 1961), and compares it with the Bohemian Unterwistersitz profile for which similar data were obtained (FINK 1962). In his summary, Firbas reviews after Gross the absolute chronology of the Late Glacial. He cites an opinion on Suess according to whom a temperature drop started in 85 000 (FIRBAS 1958), he suggests the Dry_1 to have lasted from 13 800 to 12 500, the Bölling from 11 300 to 10 300, the Alleröd from 10 500 to 8800 and the Dry_3 from 8800 to 8300 years B. C. It strikes the eye that the Alleröd, the Dry_2 and the Bölling overlap completely. Flint gives a Würm chronology from 60 000 onwards. He suggests the Bölling to have lasted from 14 000 to 13 000, the Dry_2 from 13 000 to 12 000, the Alleröd from 12 000 to 11 000, the Dry_3 to 10 700 on, presumably B. P. (FLINT 1963). Comparing these data with the previous ones published by Gross, it will appear at once that we have to do with a mass of complete or partial overlaps (overlap of "warm" and "cold" intervals) over a period of 10 000 to 15 000 years which is reputed to be the most certain stage of the C^{14} chronology and if we take into consideration the argumentation of Gage according to whom the only reliable synchronism found with the C^{14} method for the two hemispheres falls within the Late Glacial, then even the above argument will have to be eliminated.

In his comprehensive series of articles, FRENZEL (1962, 1963, 1966) also published C^{14} data originating from a number of authors. From the Polish Aurignacien there are data referring to an age over 52 000 years besides an interstadial from 33 000 (FRENZEL 1961). Dibner sets the Karginsk interstadial, a climate similar to the present one, at from 39 000 to 36 000 years (FRENZEL 1963). In his detailed panorama given of the vegetational analysis of loesses, Frenzel identifies the Stillfried B level with the Paudorf interstadial and suggests (after Klima et al.) a duration of 10 000 years (from 35 000 to 25 000 years) for it. It is mentioned in the latter paper, too, that the Polish (Srodon) and the Czech (Kneblova) scientists have given up the theory of the Göttweig (resp. Aurignacien) interstadial and identify instead of the period in question in conformity with the Dutch and Danish system with the Börup (FRENZEL 1964b, cf. HALLIK—KUBITZKI 1961). In an equally extensive series of studies GROSS (1956, 1957, 1958, 1959a, 1959b, 1964) published a multitude of radiocarbon and other isotopic age determinations putting the beginning of the Göttweig at 34 000 (GROSS 1956), then he supplies a dating of 46 350 years from the loess underneath the Göttweig (GROSS 1957), then again one of 53 000 years for the same. For the period of 9000 years between 53 000 and 44 000 (to his opinion namely, the Göttweig lasted from 44 000 to 29 000) he suggests three stadials and two interstadials which, of course, is an absurdity. In the same paper he suggests for the period of time between 29 000 and 11 000 four stadials and three interstadials (GROSS 1958). Then, after Emiliani, he puts the beginning of the Würm at 72 000 and would have it that the Göttweig was a very long and cold interstadial (GROSS 1959a). Later he sets the age of the Göttweig interstadial at 50 000 to 30 000 years (GROSS 1964). Movius expresses optimistic views on the C^{14}-method and believes synchronizing to be easy up to 40 000 years (MOVIUS 1957). According to Suess the W had its cold maximum in 15 000 (SUESS 1954a), the W_{1-2} from 80 000 to 90 000, whereas the W_{2-3} in about 45 000 (SUESS 1956). Vries gives for the W interstadial the following data: $W_1 = 44\,000$, $W_2 = 33\,000$, $W_3 = 20\,000$ (VRIES 1957). He dates the W_{1-2} at from 42 000 to 33 000, the W_{2-3} (Paudorf) at 26 000 (VRIES 1958).

The latest series of C^{14} data from Spain (Andalusia, Granada) are the following: the most ancient is the Dryas-Bölling, it lasted from 9700 to 16 900; from 16 900 to 34 100 there was an interstadial; from 34 000 to 46 200 a stadial followed by an interstadial, then again around 54 000 a stadial, all these data having been obtained from a 18 m thick sequence of layers in the Sierra Nevada (MENENDEZ AMOR—FLORSCHÜTZ 1961). If these Late Glacial data are compared with those summarized above, the confusion becomes complete, not to mention all the others which are wholly contradictory. For France there are data available from Dordogne. Charcoals of deciduous genera (*Castanea*, *Quercus*, *Corylus*, etc.) were found to be 17 000 years old (C^{14} praxis considers charcoals to be the most reliable material for examinations), this being

an absolute age which partly falls within the C^{14} range limit deemed reliable from the very beginning, while on the other hand, this is the period for which on the basis of other C^{14} data several authors suggest the greatest cold maximum of the Würm (e.g. SUESS 1954a, EMILIANI 1958, 1961, WOLDSTEDT 1958b, 1962b, GROSS 1964). However, according to the author who actually examined these charcoals the period in question was characterized by a mild climate with early springs (JACQUIOT 1960).

Aurignacien samples equally from Dordogne by means of C^{14} measurements proved to be 33 000 and 34 000 years old, and were assigned to the $Würm_1$ (MOVIUS 1965). Radiocarbon datings were executed in Denmark from the Brörup hotel bog, in Holland from the Amersfoort sites. Previously the "Brörup" interstadial was dated older than 50 000 years. According to Andersen the "Brörup" is identical with the "Göttweig", consequently the latter one, too, ought to be older than 50 000 years (TAUBER—VRIES 1958). This, however, stands in utter contradiction with a more recent conception of Gross who sets the Göttweig at from 30 000 to 50 000 years (GROSS 1964). According to the results of a recent series of measurements, the Amersfoort is 64 000, the Brörup 53 000 resp. 59 000, the Paudorf possibly 29 000 years old: from 30 000 to 50 000 glacial conditions prevailed and the late glacial sequence (Bölling, Alleröd) lasted from 10 300 to 12 300 (even the Dutch data and the Danish ones are contradictory). (ANDERSEN—VRIES—ZAGWIJN 1960). Later, Zagwijn placed the beginning of the W (= Weichselian) at 70 000 years B. P. and the Brörup at from 59 000 to 53 000 (ZAGWIJN 1961). In Poland 38 000 years were obtained for the W_2 stage (ROZYCZKY 1961), which is by 4000 to 5000 years more than the figure given for the W_1 by Movius. Srodon, already under the effect of the system elaborated by Zagwijn et al., abandons the denominations Aurignacien and Göttweig and assigns the main Polish interglacial to the Brörup from where he obtained 40 000 years (SRODON 1964). This nevertheless differs considerably from the Brörup dating of Zagwijn et al. (from 53 000 to 59 000). In Czechoslovakia a duration of from 14 000 to 19 000 was obtained for the W_3, the "Paudorf" interstadial was found to have lasted from 25 000 to 30 000, the W_2 to be over 52 000 years, the Göttweig over 55 000 years and the beginning of the W_1 also over 55 000 years (KLIMA—KUKLA 1961, LOZEK—KUKLA—SIBROVA 1961). These datings overlap the interpretation of Gross and partly also that of Zagwijn et al. Other Czech datings for the W_{2-3} extend from 14 000 to 52 000 years (KLIMA—KUKLA—LOZEK—VRIES 1961, cf. LOZEK 1965).

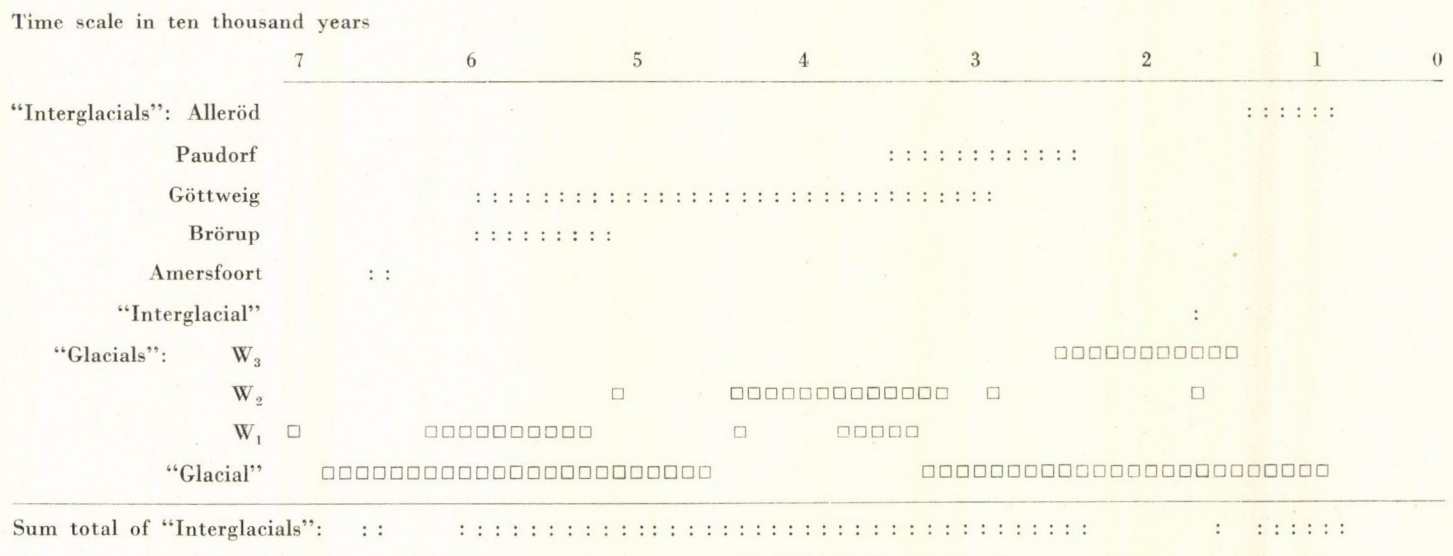
In Yugoslavia datings from a 80 m sequence of strata containing pollen, point to an age of 53 000 years for the W_1, of 44 000 years for the „Göttweig", to 29 000 years for the W_2, to 26 000 years for the Paudorf and to 25 000 years for the W_3, while they indicate the Late Glacial to have extended from 17 000 to 12 000 years (SERCELJ 1965). Could thus the W_2 and the W_3, including the Paudorf have lasted only 5000 to 6000 years?

In the Soviet Union, in Lithuania, on the basis of the Dutch-Danish system, 64 000 to 65 000 years were suggested for the Brörup-Amersfoort, from 30 000 to 23 000 for the Paudorf, from 55 000 to 33 000 for the pleniglacial (GUDELIS 1961). For the Tajmir mammoth (POLUTOFF 1955) a relatively young age was obtained: 12 000 years (Alleröd?). In the Soviet Far East the duration of two warm intervals was placed (on the basis of bedding) at from 100 000 to 63 000 years and from 40 000 to 22 000 years, respectively, and that of the two cold intervals at from 63 000 to 40 000 and from 22 000 to 7000 years respectively (CHEMEKOV 1964). In Persia the Moustérien proved to be 50 000 years old (SOLECKI 1961). In America 13 500 to 10 000 years were obtained for the Alleröd (DEEVEY 1957, LEOPOLD 1957). According to Hammen-Head the warm and cold periods (always on the basis of the C^{14} method) are in South America of an identical age with those of Europe (HAMMEN-HEAD 1957). Flint's absolute age division has been dealt with in the foregoing. In New Zealand a cold phase around 37 000, an interstadial around 27 000, and from 23 000 to 16 000 years again a cold phase were found. The Holocene was found to have started everywhere about 10 000 (WOLDSTEDT 1962a).

In Hungary, at the reopening of the classical Ságvár loess site also charcoals were found and by means of C^{14} examinations the lower "cultural layer" proved to be 18 600, the upper one 17400 years old (Gábori V. 1960, Gábori M. 1965). This does not differ substantially from the previous datings but specifies them in more detail. For the rest Gábori presents Gravettian data only from 24 000 to 26 000 years old as well as two Austrian data, 32 000 years for the W_2 and 31 800 years for the $Würm_{1-2}$. On the other hand she also publishes a dating from the French Lower Solutréen, based on information received by letter from P. Smith (USA) and that is 20 600 years! Kretzói and Vértes subdivide the Würm into ten phases, of which the 4th Tata-phase is 50 000, the so-called 5th Szeleta-phase from 37 000 to 41 000, and the 6th Tokod-phase 36 000 years old. The 7th Istállóskő-phase has been dated to 30 000 years and the Bodrogkeresztúr find was also assigned to the latter with 28 700 years. No radiocarbon datings are available for the 8th Pilisszántó-phase but it is believed to have been the coldest one, around 19 000 B. C. The aforementioned data from Ságvár and those from Arka (17 000 and 13 000 years respectively) have been assigned to the 9th Arka-phase which must thus have lasted from 18 000 to 13 000 years at least. The 10th Palánk-phase was set at a time after 10 300 years (on the basis of a private letter from Münnich [KRETZOI—VÉRTES 1965]). The so-called "Istállóskő" Aurignacien I proved to be 30 670 $\pm$ 50 years old (VÉRTES 1957), while for the Aurignacien II situated above it 30 710 $\pm$ 600 years were obtained (VÉRTES 1959b) which means that the older stage is younger! In this context Vértes mentions Cherdincev who has obtained by means of the protactinium/thorium method data identical with the astrological ones (CHERDINCEV 1956). Examinations of the cultural layer of the Tata site indicated on the basis of chalk tuff derived from borings, 50 000 years, then again on the basis of bones coming from the cultural layer, 36 000 years. It is true that the Groningen workers who had analysed the samples have referred in both cases to the none too suitable nature of tuff and bones and to water infiltration. VÉRTES thinks 50 000 years to be nearer the truth (KRETZOI—VÉRTES 1965). More noteworthy still are the data derived from charcoals originating from the latest opening-up of the Moustérien site at Érd. A sample taken from the upper "d" layer was first dated at 38 000 and then at 35 000 years. Charcoals from the younger "e" layer situated above it have been stated to be 44 000 years old (GÁBORI 1968)! Thus the younger layer is from 6000 to 9000 years older!

The above discussed data are summarized in a table-diagram (Fig. 1). In the diagram it is, of course, a debatable point, that the determination of the geological or relative chronological situation may not have been faultless and that stages qualified as W_2 are, in reality, W_3 or W_1, etc. But all these objections can safely be disregarded because radiocarbon examinations supply absolute ages. So, if we limit ourselves to check the sequence of glacials and interglacials as represented in the Table, we will find, to our great surprise, in the glacial sequence ranging from 8000 to 70 000 years B. C., one single continuous glacial lasting 62 000 years, and for the same period of time, one nearly continuous interglacial! And this is the full range of Pleistocene radiocarbon dating!

Should all this mean that the radiocarbon method is entirely useless? Hardly. It rather means that the method and its results ought to be viewed objectively and critically; furthermore, that the age determinations it supplies cannot be accepted without reserve, the method having a number of partly well-known, partly unelucidated sources of error. As to the sources of error so far cleared up, I shall briefly refer to the so-called Suess-effect (FÖLDVÁRI 1965) due to the diluent action of large quantities of CO_2 introduced into the atmosphere by industrial activity and which workers try to eliminate by means of dendrochronology. There were times when nuclear explosions caused some trouble. A considerable source of error is infiltration caused by hard waters (MÜNNICH 1957) an error which beyond 30 000 years cannot be eliminated (MÜNNICH 1960). Then again no one has ever taken into consideration that also recent atmospheric infiltration may be possible in the form of carbonate and hydrocarbonate which in



Alleröd: Andersen, Sv. Th.—Vries, H.—Zagwijn, W. H. (1960), Deevey, E. S. (1957), Firbas, F. (1958), Kretzói, M.—Vértes, L. (1965), Polutoff, N. (1955), Woldstedt, P. (1962b); *Paudorf:* Frenzel, B. (1964), Lozek, V.—Kukla, J. (1959), Tauber, H. (1965), Woldstedt, P. (1958); *Göttweig:* Firbas, F. (1958), Firbas, F.—Frenzel, B. (1960), Frenzel, B. (1966), Gross, H. (1958), Narr, K. J. (1959), Tauber, H. (1965), Vértes, L. (1965); *Brörup:* Frenzel, B. (1962), Gross, H. (1964), Srodon, A. (1964), Tauber, H.—Vries, H. (1958), Woldstedt, P. (1962b); *Amersfoort:* Andersen, Sv. Th.—Vries, H.—Zagwijn, W. H. (1960), Firbas, F.—Frenzel, B. (1960), Frenzel, B. (1962), Gross, H. (1964), Woldstedt, P. (1962b),
W_3: Klima, B.—Kukla, J. (1961), Lozek, V.—Kukla, J. (1959), Menendez Amor, J.—Florschütz, F. (1961), Sercelj, A. (1965), Vries, H. (1957), Woldstedt, P. (1962b),
W_2: Andersen, Sv. Th.—Vries, H.—Zagwijn, W. H. (1960), Emiliani, C. (1958), Klima, B.—Kukla, J. (1961), Lozek, V.—Kukla, J. (1959), Rozycki, S. Z. (1961a), Sercelj, A. (1965), Vries, H. (1957), Woldstedt, P. (1962b).
W_1: Emiliani, C. (1958), Felgenhauer, F.—Fink, J.—Vries, H. (1959), Gábori, V. (1968), Klima, B.—Kukla, J. (1961), Rosholt, J. H. (1961), Sercelj, A. (1965), Vries, H. (1957), Woldstedt, P. (1962b), „*Glaciál*": Emiliani, C.—Geiss, J. (1957), Fink, J. (1962), Flint, R. F. (1963), Gross, H. (1957), Gross, H. (1964), Lozek, V.—Kukla, J.—Sibrova, V. (1961), Vries, H. (1958), Zagwijn, W. H. (1961).

Fig. 1. Absolute chronology of the Würm "glacials" and "interglacials" in the last 72 thousand years on the basis of some direct or indirect radiocarbon age determinations

the case of materials originally containing carbonate (e.g. bones) cannot be removed. Similarly, carboniferous, i.e. cave waters coming from below also adulterate the results. The starting C^{14} contents of organic substances depend not only on the atmosphere but on the geographical position, and on the amount of carbonate absorbed by the plants too. Though abundant partial results are available on this subject, these, even if they have been elaborated methodically and statistically, cannot be considered other than random tests. We still lack a comprehensive and detailed work (actually a monography!) which would discuss with regard to the whole earth the measure of possible deviations in the starting C^{14} contents in recent organic materials, establish the regularities present in the process of radiocarbon accumulation, and clear up its causes. The basis of radiocarbon chronology, its sine qua non is constituted by the hypothesis that the C^{14} contents of the atmosphere have been constant over a long geological period. Though fluctuations of 1 to 2 per cent have already been demonstrated (TAUBER 1965), quite recently it was ascertained that in the recent past (even in the last few thousand years) fluctuations up to 30 per cent leading to wholly erroneous datings had occurred (e.g. a deviation of from 800 to 1000 years for a growth-ring 5800 years old!), (Ferguson, Huber, Suess 1966: Huber 1967; Frenzel 1968). We have no guarantee whatever that in a more distant past fluctuations of an even higher rate did not occur. Thus we cannot deny that the radiocarbon method is basically saddled with serious sources of error and is far from supplying absolute chronological data.

The radiocarbon investigations and results, however, leave us facing the problem to whta extent the various plants absorb C^{14} under different climatic and geographical conditions and during the different seasons, what do these fluctuations depend on and what is their physiological effect? And this, in my opinion, opens up a new field of research with a direct bearing also on agricultural practice.

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REFERENCES

ANDERSEN, Sv. Th.—VRIES, H.—ZAGWIJN, W. H. (1960): Climatic change and radiocarbon dating in the Weichselian Glacial of Denmark and the Netherlands. Geologie en Mijnbouw, **39,** 38—42.

CHEMEKOV, Ju. F.— Чемеков, Ю. Ф. (1964): Четвертичная система Дальнего Востока Report of the VIth Intern. Congr. on Quaternary. Lodz p. 43—52.

CHERDINCEV, V. V.— Чердинцев, В. В. (1956): Определение абсолютного возраста палеолита. Сов. Арх., **25,** 64—66.

DEEVEY, E. S. (1957): Pollen Stratigraphy of Eastern North America and Western Europe. INQUA V Cong. Intern. Résumés des Communications. 45—46.

DÜCKER, A. (1961a): C^{14} datings on soil of the Weichsel-Glaciation in Schleswig-Holstein. VIth INQUA Congr. Abstracts of Papers. 205.

DÜCKER, A. (1961b): Weichselzeitliche Bodenbildungen in Schleswig-Holstein und ihre Datierung durch C^{14} Messungen, ein Beitrag zur Gliederung der Weichselvereisung. VIth INQUA Congr. Abstracts of Papers. 21.

DYLIK, J. (1957): The morphogenetic and stratigraphic role of fossil soils in Poland. INQUA V. Congr. Intern. Résumés des Communications. 50.

EBERS, E. (1961): The new found Laufen-Interstadial in Upper Bavaria. VIth INQUA Congr. Abstr. of Papers. 21.

EBERS, E. (1964): Neues zur Frage des Laufen-Interstadials in den Alpen. Report of the VIth Intern. Congr. on Quaternary 2. Lodz, 71—76.

EMILIANI, C. (1958): Paleotemperature analyses of core 280 and pleistocene correlations. Journ. Geol., **66,** 264—275.

EMILIANI, C.—GEISS, J. (1957): On glaciations and their causes. Geol. Rundschau, **46,** 576—601.

FELGENHAUER, F.—FINK, J.—VRIES, H. (1959): Studien zur absoluten und relativen Chronologie der fossilen Böden in Österreich. Arch. Austr., **25,** 35—73.

FERGUSON, C. W. — HUBER, B. — SUESS, H. E. (1966.) Determination of the age of Swiss lake dwellings as an example of dendrochronologically calibrated radiocarben dating. Zeitschr. f. Naturforschung 21a, 1173—1177.

FINK, J. (1962): Studien zur absoluten und relativen Chronologie der fossilen Böden in Österreich. II. Wetzleinsdorf und Stillfried. Arch. Austr., **31,** 1—18.

FIRBAS, F. (1958): Floren- und Vegetationsgeschichte seit dem Ende des Tertiärs. Fortschritte der Botanik, **20,** 80—99.

FIRBAS, F.—FRENZEL, B. (1960): Floren- und Vegetationsgeschichte seit dem Ende des Tertiärs. Fortschritte der Botanik, **22,** 87—111.

FLINT, R. F.—Флинт, Р. Ф. (1963): Ледники и палеогеография плейстоцена. Москва, 1—576.

FÖLDVÁRI, M. (1965): Földtani időszámítás a klasszikus módszerek és az abszolút módszerek összehasonlításával (Geological chronology. Comparison of the classic and absolute methods). Mérnöki Továbbképző Intézet előadássorozataiból, 4422. Budapest.

FRENZEL, B. (1961): Über einige während der INQUA-Tagung in Polen behandelte paläobotanische Probleme. Eisz. u. Gegenw., **12,** 238—240.

FRENZEL, B. (1962): Floren- und Vegetationsgeschichte seit dem Ende des Tertiärs. Fortschritte d. Botanik, **24,** 101—122.

FRENZEL, B. (1963): Floren- und Vegetationsgeschichte seit dem Ende des Tertiärs. Fortschritte d. Botanik, **25,** 172—189.

FRENZEL, B. (1964b): Zur Pollenanalyse von Lössen. Eisz. u. Gegenw., **15,** 5—39.

FRENZEL, B. (1966): Floren- und Vegetationsgeschichte seit dem Ende des Tertiärs (Historische Geobotanik). Fortschr. d. Bot., **28,** 274—288.

GAGE, M. (1965): Accordant and discordant glacial sequences. INQUA USA GSA Spec. of Papers., **84,** 393—414.

GÁBORI, M. (1965): Der zweite paläolitische Hausgrundriß von Ságvár. Acta Arch. Hung., **17,** 111—127.

GÁBORI, V. (1960): A ságvári telep abszolút kormeghatározásai (Absolute age determination of Ságvár deposit). Arch. Ért., **2,** 125—129.

GÁBORI, V. (1968): La station du paléolithique moyen d'Érd Hongrie. Budapest.

GROSS, H. (1956): Das Göttweiger Interstadial, ein zweiter Leithorizont der letzten Vereisung. Eisz. u. Gegenw., **7,** 87—101.

GROSS, H. (1957): Die Fortschritte der Radiocarbonmethode. 1952—1956. Eisz. u. Gegenw., **8,** 141—180.

GROSS, H. (1958): Die bisherigen Ergebnisse von C^{14}-Messungen und paläontologischen Untersuchungen für die Gliederung und Chronologie der Jungpleistozäns in Mitteleuropa und den Nachbargebieten. Eisz. u. Gegenw., **9,** 155—187.

GROSS, H. (1959a): Noch einmal: Riss oder Würm? Eisz. u. Gegenw., **10,** 65—76.

GROSS, H. (1959b): Zur Frage der Zuverlässigkeit und Brauchbarkeit der Radiocarbon-(C14) Methode in Vorgeschichtsforschung und Quartärgeologie. Quartär., **10—11,** 27—44.

GROSS, H. (1964): Das Mittelwürm in Mitteleuropa und angrenzenden Gebieten. Eisz. u. Gegenw., **15,** 187—198.

GUDELIS, B. K. (1961): Ocherk po geologii i paleogeografii chetvertichnovo perioda (antropogena). Litvü. Instytut Geologiczny Prace. 34. Czwartorzed Europy srodkowej i wschodniej., **1,** 423—497.

HALLIK, R.—KUBITZKY, K. (1961): Über die Vegetationsentwicklung des Weichsel-Interstadials aus Hamburg-Hahrenfeld. Eisz. u. Gegenw., **12,** 92—98.

HAMMEN-HEAD, T. (1957): Pollenanalysis of pleistocene Lakesediments from the sabana de Bogotá (Colombia, South America). INQUA V Congr. Intern. Résumés des Communications, 75.

HUBER, B. (1967): Neues von Radiocarbon- und Jahrringdatierung. Mitt. aus der Staatsforstverw. Bayerns, **36,** 97—104.

JACQUIOT, C. (1960): Détermination de bois fossiles provenant de la grotte de Lascaux, Montignac-sur-Vizère (Dordogne). Bull. Soc. Bot. Franç., **107,** 15—17.

KLIMM, B.—KUKLA, J. (1961): Absolute chronological data of Czechoslovak Pleistocene. Instytut Geologiczny Prace. 34. Czwartorzed Europy srodkowej i wschodniej, **1,** 171—174.

KLIMM, B.—KUKLA, J.—LOZEK, V.—VRIES, H. (1961): Stratigraphie des Pleistozäns und Alter des paläolitischen Rastplatzes in der Ziegelei von Dolni-Vestonice (Unter-Winternitz). Anthropozoikum, **11,** 93—145.

KRETZOI, M.—VÉRTES, L. (1965): The role of vertebrate faunae and palaeolithic industries of Hungary in Quaternary stratigraphy and chronology. Acta Geol., **9,** 125—144.

LEOPOLD, E. B. (1957): Comparisons by pollen chronology of late glacial climate in Eastern USA with the Alleröd of Northern Europe. INQUA V. Congr. Intern. Résumés des Communications. 105—106.

LOZEK, V. (1965): Molluscan faunas and absolute chronology. Report VIth Intern. Congr. on Quaternary. 1. Lodz, 687—698.

LOZEK, V.—KUKLA, J. (1959): Das Lößprofil von Leitmeritz an der Elbe, Nordböhmen. Eisz. u. Gegenw., **10,** 81—104.

LOZEK, V.—KUKLA, J.—SIBROVA, V. (1961): Outline of the stratigraphy of the Czechoslovak Quaternary. Instytut Geologiczny Prace. 34. Czwartorzed Europy srodkowej i wschodniej, **1,** 155—170.

MENENDEZ AMOR, J.—FLORSCHÜTZ, F. (1961): Un aspect de la végétation en Espagne méridionale durant la dernière glaciation et l'Holocéne. VIth INQUA Congr. Abstracts Papers, 119.

MOVIUS, H. L. (1957): Radiocarbon dates and paleolithic archeology. INQUA V. Congr. Intern. Résumés des Communications, 132.

MOVIUS, H. L. (1965): Preliminary results of the Abri Pataud Excavations, Les Eyzies (Dordogne) 1958 to 1961. Atti del VI. Congr. Intern. delle scienze preistoriche e protostoriche, **2,** 151—157.

MÜNNICH, K. O. (1957): Erfahrungen mit der C^{14}-Datierung anderer kohlenstoffhaltiger Materialen als Holz und Holzkohle. INQUA V Congr. Intern. Résumés des Communications, 133—134.

MÜNNICH, K. O. (1960): Die C^{14}-Methode. Geol. Rundschau, **49,** 237—244.

NARR, K. J. (1959): C^{14} Daten und die Gliederung des Jungpleistozäns. Forschungen und Fortschritte, **33,** 147—151.

POLUTOFF, N. (1955): Das Mammut von Taimyr. Eisz. u. Gegenw., **6,** 152—158.

ROSHOLT, J. N. (1961): Pleistocene chronology by the Pa^{231} Th^{230} method. VIth INQUA Congr. Abstracts of Papers, 180.

ROZYCKI, S. Z. (1961a): From the Baltic to the Tatras. INQUA Intern. Assoc. on Quaternary Res. VIth Congr. Guide-book of Excursions, 2.1. Lodz, 11—115.

ROZYCKI, S. Z. (1961b): Sur les changements climatiques pendant l'avant-dernière époque interglaciaire (Mindel-Riss). VIth INQUA Congr. Abstracts of Papers, Suppl., **1,** 34—35.

SERCELJ, A. (1965): Paleobotanicne raziskave in zgodovina ljubljanskega barja. Paleobotanical examinations and the development of Ljubljana moor. Geologija. Razprave in porocila, **8,** 5—27.

SOLECKI, R. S. (1961): Shanidar cave, a Late Pleistocene site in Northern Iraq. VIth INQUA Congr. Abstracts of Papers, 144.

SRODON, A. (1964): Paleobotany and stratigraphy of the Late-Pleistocene deposits in the Northern Carpathians. Report of the VIth Intern. Congr. on Quaternary. 2. Lodz 483—486.

SUESS, H. E. (1954): Geological survey of radiocarbon dates I. Science, **120,** 467—473.

SUESS, H. E. (1956): Absolute chronology of the late glaciation. Science, **123,** 355—357.

TAUBER, H. (1965): Recent developments in C^{14} datings. Report of the VIth Intern. Congr. on Quaternary. 1. Lodz, 729—742.

TAUBER, H.—VRIES, H. (1958): Radiocarbon measurements of Würm interstadial samples from Jutland. Eisz. u. Gegenw., **9,** 69—71.

VÉRTES, L. (1957): Az első hazai anyagon végzett rádiocarbon vizsgálat (The first radiocarbon measurement on Hungarian material). Arch. Ért., **84,** 222.

VÉRTES, L. (1959): Das Moustérien in Ungarn. Eisz. u. Gegenw., **10,** 21—40.

VÉRTES, L. (1965): Über die Evolution einer altsteinzeitlichen Kultur in Ungarn. Atti del VI Congr. Intern. delle science preistoriche e protostoriche, **2—14,** 164—168.

VÉRTES, L.—VRIES, H. (1959): Az istállóskői barlang aurignaci II. kultúrájának rádiocarbon kormeghatározása (Radiocarbon age determination of Aurignac II. from the Istállóskő cave). Arch. Ért., **86,** 195.

DE VRIES, H. (1957): C^{14} dates for Würm interstadials from different localities. INQUA Vth Congr. Intern. Résumés des Communications, 197.
DE VRIES, H. (1958): Radiocarbon dates for upper Eem and Würm-interstadial samples. Eisz. u. Gegenw., **9,** 10—17.
DE VRIES, H.—WAARD, H. (1964): Die Untersuchungen des C^{14}-Laboratoriums zu Groningen. In: „Tata" Budapest, 35—36.
WOLDSTEDT, P. (1958): Eine neue Kurve der Würm-Eiszeit. Eisz. u. Gegenw., **9,** 151—154.
WOLDSTEDT, P. (1962a): Die Vergletscherung Neuseelands und die Frage ihrer Gleichzeitigkeit mit den europäischen Vereisungen. Eisz. u. Gegenw., **12,** 18—24.
WOLDSTEDT, P. (1962b): Über die Gliederung des Quartärs und Pleistozäns. Eisz. u. Gegenw., **13,** 115—124.
ZAGWIJN, W. H. (1961): Vegetation, climate and radiocarbon datings in the Late Pleistocene of the Netherlands. Memoirs of the Geological Foundation in the Netherlands, **14,** 15—45.

TRANSGRESSION IN THE EARING OF HYBRID WHEAT POPULATIONS

Under Hungarian conditions development of early varieties is one of the most important objectives of wheat breeding. Therefore possibilities of producing early forms are always sought for.

Earliness is inherited in a relatively simple way. According to investigations carried out by AYAD (1952), and CRUMPACKER—ALLARD (1962), earliness is controlled by two partially dominant genes, while lateness only by one.

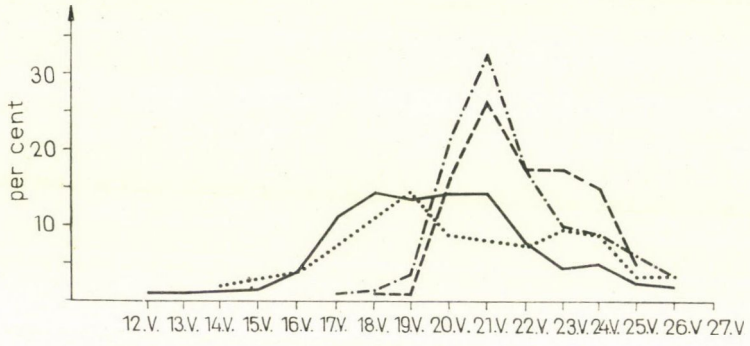

Fig. 1. Earing of Besostaya 1, Fertődi 293 F_2 and their hybrids (——— Besostaya 1, ——— Besostaya 1 × Fertődi 293 F_2, • • • • Fertődi 293 × Besostaya 1 F_2, · — · — Fertődi 293)

Many authors (THOMPSON 1918, 1921, VAVILOV 1935, GFELLER 1937, SHEN-TAI—CHANG 1938) observed also the transgression of earliness in wheat crossings. There are, however, but a few data available on the frequency and breeding importance of this phenomenon.

In the course of our investigations the appearance of transgression in the F_2 generation of the combination of Besostaya 1 × Fertődi 293 and Fertődi 293 × Besostaya 1, and the effects of back- and top-crossing on the earing dynamics of Besostaya 1 × Fertődi 293 were studied.

Earing dynamics was determined by recording the earing time of each member of the population. Distribution of data was expressed and represented as the percentage of the total number of plants. 80—120 plants per combination sown sparsely (40 × 10 cm) were examined in 1966.

Fig. 1 shows that the earing dynamics of the parents is similar. In the variety Fertődi 293 there is a somewhat higher number of plants that form ears early, while in Besostaya 1 those earing later are in majority. The range of variation is also similar.

Earing dynamics of the hybrid population Besostaya 1 × Fertődi 293 F_2 and Fertődi 293 × Besostaya 1 F_2 is different from that of the parents. There is a wider range of variation in the time of earing. Earing of the hybrid populations and the parents completed at the same time, but that of the hybrids started much earlier. Among the hybrids there were many plants which formed ears 3—4 days earlier than both parents. There was no significant difference in earing dynamics between linear and reciprocal crossings.

Early forms found in the hybrid population are considered as results of transgression. This is possible because Besostaya 1 has a shorter vernalization and light period than Fertődi

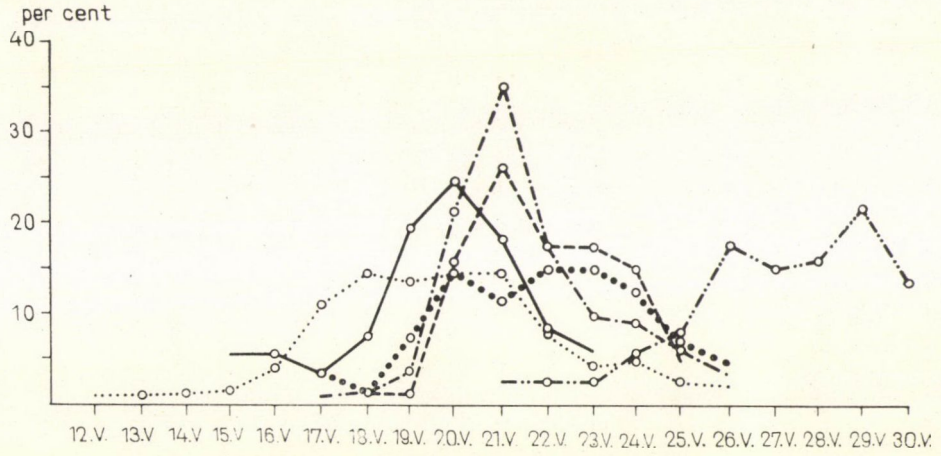

Fig. 2. Effect of back- and top-crossing on the dynamics of earing (- - - - - - Besostaya 1, ·—·—· Fertődi 293, ... Besostaya 1 × Fertődi 293 F_2 ——— (Besostaya 1 × Fertődi 293 F_2) × Besostaya 1, ··—··— Mironovskaya 808, • • • • (Besostaya 1 × Fertődi 293 F_2) × Mironovskaya 808

293, while in the latter the period between the beginning of development in spring and the time of earing is shorter (Balla 1968). Therefore in the hybrids of the two varieties the length of the vegetative period may show favourable trends.

The F_2 generation of the combination Besostaya 1 × Fertődi 293 was back-crossed to Besostaya 1 and top-crossed by Mironovskaya 808. Earing dynamics of the parents and the obtained hybrids is shown by Fig. 2.

As a reaction to back-crossing the earing dynamics of the hybrid became more similar to that of the parents. The variation range of earing was not so wide any longer. In general, however, the hybrid population formed ears earlier than the parents even after the back-crossing, and many plants earing 1—2 days earlier than the parents were found among them.

Thus, back-crossing decreased the proportion of early forms, but transgression still could be observed.

Mironovskaya 808 — as it is shown by the figure — formed ears later than Besostaya 1 and Fertődi 293. Earing dynamics of the hybrid population was also modified by its longer vegetative period. The range of earing variations in the hybrid population became wider, but did not exceed that of either the Besostaya 1 or the Fertődi 293. The earing curve deviates from the normal and is flatter than that. Late forms similar to Mironovskaya 808 cannot be found in the population. Earing of the latest forms takes place at the same time as that of the early specimens of Mironovskaya 808.

Transgression appeared, thus, in the earing of hybrid populations obtained by top-crossing.

Combinations examined offer the possibility of producing early varieties.

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REFERENCES

AYAD, M. A. G. (1952): Inheritance studies of some qualitative and quantitative characters in Egyptian varieties of wheat. Proc. Egypt. Acad. Sci., **8,** 26—38.

BALLA, L. (1968): Developmental physiological problems of the production of high-yielding, winter-hardy wheat varieties having a short growing season. Acta Agronomica Acad. Sci. Hung., **17,** 131—138.

CRUMPACKER, D. W.—ALLARD, R. W. (1962): A diallel cross analysis of heading date in wheat. Hilgardia, **32,** 275—318.

GFELLER, F. (1937): Inheritance of earliness of heading and other characters in Garnet × Red Fife cross. Sci. Agr., **17,** 482—491.

SHEN, T. H.—TAI, S. E.—CHANG, S. C. (1938): The transgressive inheritance of reaction to flag smut, earliness of heading, partial sterility and stiffness of glumes in a varietal cross of wheat. Jour. Amer. Soc. Agron., **30,** 68—79.

THOMPSON, W. P. (1918): The inheritance of the length of the flowering and ripening periods in wheat. Roy. Soc. Canada, Proc. and Trans., **3,** 69—87.

THOMPSON, W. P. (1921): Earliness in wheat and its inheritance. Sci. Agr., **1,** 193—199.

VAVILOV, N. I.—Вавилов, Н. И. (1935): Научные основы селекции пшеницы. Селхозгиз Москва—Ленинград.

EFFECT OF BENZIMIDAZOLE ON ROOT FORMATION IN PHASEOLUS VULGARIS L.

Results obtained so far show that cytokinins enhance the synthesis of nucleic acid, increase its quantity and so result in a frequent cell division (GALSTON—BAKER—KING 1953, FORSYTH—SAMBORSKY 1960, KING—HSU—JING 1963, MILLER 1960, COLLIER 1962, LEOPOLD 1964, SKOOG—STRONG—MILLER 1965, OSBORNE 1965, FOX 1966); root formation response especially to benzyladenine and kinetin was demonstrated by many experiments (FRIES 1960, GASPAR—XANFFLAIRE 1967, GRACZA—POZSÁR—SZŐKE 1969). Present paper contains a study on the effect of benzimidazole on root development in bean.

Bean seeds were swollen for a day in a Petri-dish, then on the second day benzimidazole was added in quantities of 30, 50, 100 mg/l. The development was followed with attention every day; on the 7th or 8th day roots were cut off, fixed, then, after paraffine bedding, microtome section series were made of them for anatomical examination.

The examinations displayed that benzimidazole given in 30, 50 and 100 ppm quantities respectively, exerted a varied effect on root organization. As a comparison, the development of beans germinated in distilled water at the end of the experiment is presented first. Bean seeds swell in a few hours, toward the end of the second day the seed-coat bursts, and the developing radicle with the elongating hypocotyle comes out. The initially intensively growing hypocotyle is continued downward in the collar and the rapidly developing and gradually tapering embryonal root. The first lateral roots develop on the contact line of collar and embryonal root along four orthostichies; then, in the direction of the cotyledons on the collar.

as well as at the lower end of the hypocotyle further lateral root levels appear. These are called basipetal roots. The typical acropetal roots in the direction of the root tip begin to develop subsequently (GRACZA 1968). Soon after the development of cotyledons the primary leaves also appear on the elongating stem.

Benzimidazole in a concentration of 30 ppm has hardly any effect. The root develops similarly to that of the control. Basipetal roots in the direction of the cotyledons appear in time, though some reduction in length can already be observed. On the other hand, in the

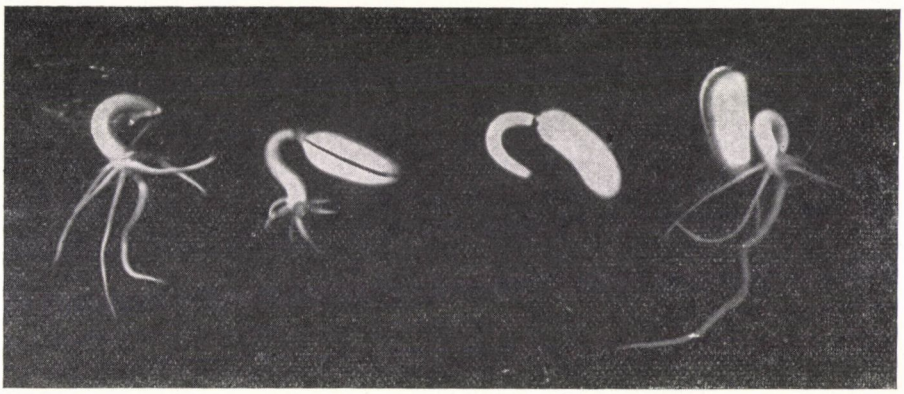

Fig. 1. Bean seedlings grown in benzimidazole solutions of 30, 50, 100 ppm concentrations. Right: the control

formation of the typical acropetal roots some inhibition is shown. These lateral roots differentiate only in two or three horizons, and are very short.

In case of a benzimidazole treatment of 50 ppm concentration the growth of the main root is also inhibited to some extent. Its length is reduced by half as compared to the control. On the collar the development of basipetal roots starts, but soon stops. Acropetal root formation is completely inhibited.

Under the influence of benzimidazole applied in a concentration of 100 ppm, the development of the radicle following the swelling starts, and at the same time the hypocotyle elongates. It is characteristic that later in the main root the cell division and elongation become inhibited and the size of the root does not grow further. In case of basipetal lateral roots the inhibition sets in already at the initial stage. The same refers to the acropetal lateral roots too (Fig. 1).

Cross and longitudinal sections were made of the roots of the control and of those of plants treated with benzimidazole in a concentration of 100 ppm, for the purpose of histological examinations.

The longitudinal section made of the root of the control plants shows that the outward layers of the 14 or 15 cortical cell rows under the one-cell layered rhizoderm have become corky, while the inward cell row has developed into a Caspary-striped endoderm. In the central cylinder — due to the activity of the undulate cambium developed meantime — inwardly xylem and outwardly phloem develops (Fig. 2).

Benzimidazole applied in a concentration of 100 ppm evokes not only outward changes but also considerable alteration in the tissue structure. In the growing tip of the root cell division stops soon after germination, and the reduced growth of the root is only the result of a cell elongation, which can be observed in the longitudinal section by the slightly longer but smaller sized cells of the cortex and central cylinder as compared to the control. When looked at in

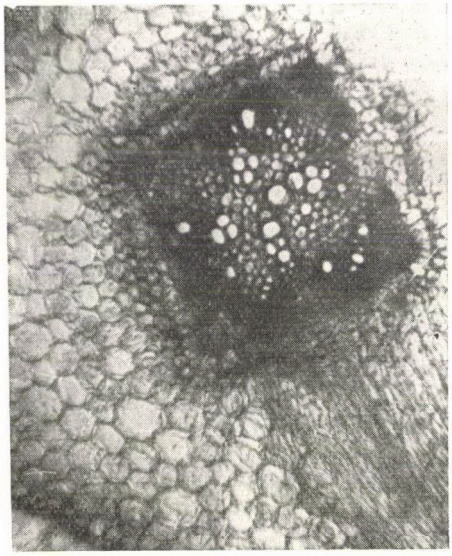

Fig. 2. Root cross section of the control immediately under the collar. *r* = rhizoderm, *e.k.* = primary cortex, *st* = central cylinder (obj. 20×, oc. 5×)

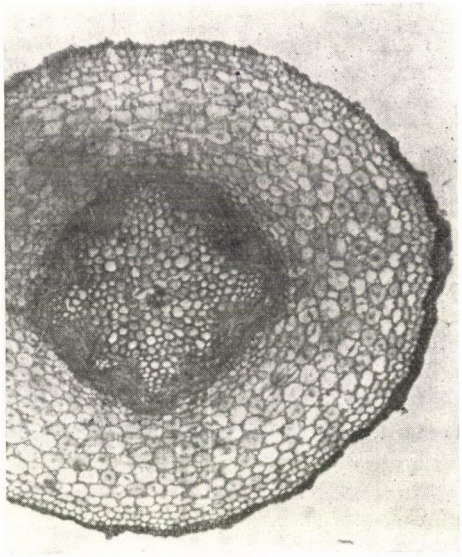

Fig. 3. Root cross section of plants treated with 100 ppm benzimidazole (obj. 20×, oc. 5×)

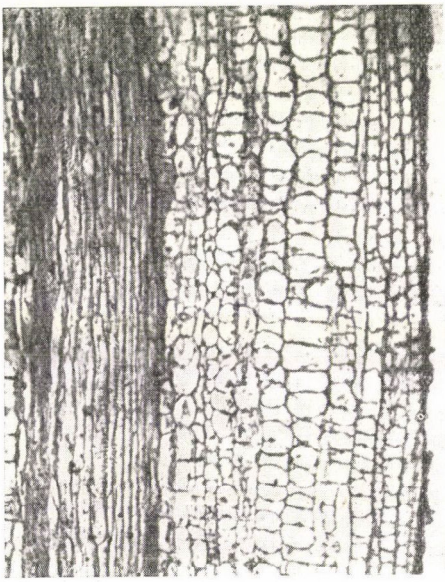

Fig. 4. Longitudinal root section of control plants (obj. 20×, oc. 5×)

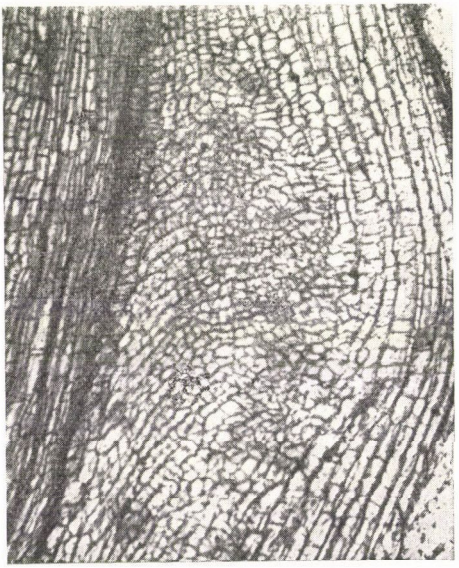

Fig. 5. Longitudinal root section of plants treated with 100 ppm benzimidazole (obj. 20×, oc. 5×)

cross section, xylem is produced in the central cylinder to a much lower extent, and the secondary thickening in the cell walls is also of smaller degree. Coming back to longitudinal sections it was found that — although lateral root formation sta ed and the growing tips of undifferentiated lateral roots grew into the cortex, — the cells early ceased to be meristemic and the growing tip became an undifferentiated parenchyme tissue of low plasm content (Figs. 3, 4, 5).

To sum up the results of examinations we have arrived at the conclusion that benzimidazole exerts an inhibiting effect — of an extent depending on the concentration — on the main and lateral root formation of the bean. This inhibition acts on the cell division and cell elongation.

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REFERENCES

Collier, H. O. J. (1962): Kinins. Sci. Am. **207,** 111—118.

Forsyth, F. R.—Samborski, D. J. (1960): Effects of kinetin and benzimidazole on the growth of etiolated pea stems and barley coleoptiles. Canad. J. Bot., **38,** 875—881.

Fox, J. E. (1966): Incorporation of a kinin, N—6-benzyladenine soluble RNA. Plant Physiol., **41,** 75—82.

Fries, N. (1960): Effect of adenine and kinetin on growth and differentiation of *Lupinus.* Physiol. Plant., **3,** 468—481.

Galston, A. W.—Baker, R. S.—King, J. W. (1953): Benzimidazole and the geometry of cell growth. Physiol. Plant., **6,** 863—872.

Gaspar, T.—Xanfflaire, A. (1967): Effect of kinetin on growth auxin catabolism, peroxidase and catalase activities. Planta, **7,** 252—257.

Gracza, P. (1968): Some observations on the formation of lateral roots in common bean *(Phaseolus vulgaris* L.). Acta Agronomica Acad. Sci. Hung., **17,** 291—298.

Gracza, P.—Pozsár, B.—Szőke, É. (1969): Kinetin és benziladenin hatása a babgyökér szerveződésére (Effect of kinetin and benzyladenine on root organization in bean). Bot. Közl., **56,** 105—111.

King, C. C.—Hsu, T. Y.—Jing, G. A. (1963): Action of benzimidazole on protein synthesis in detached leaves. Acta Biol. Exptl. Sinica, **8,** 163—169.

Leopold, A. C. (1964): Plant growth and development. McGraw-Hill, New York.

Miller, C. O. (1960): An essay for kinetin-like materials. Plant Physiol., **35,** XXVI.

Osborne, D. J. (1965): Interaction of hormonal substances in the growth and development of plant. J. Sci. Food Agr., **16,** 1—13.

Skoog, F.—Strong, F. M.—Miller, C. O. (1965): Cytokinins. Science, **148,** 532—533.

LIFE AND WORK OF JÓZSEF FÁBIÁN

Life

1761—1825. These two years mark József Fábián's life and work. To understand and appreciate this excellent scientist, the era he lived and worked in must be known.

It was the beginning of a new era in the life of nations. With the poet's words: "The iron bars of nations fall, bridles and ropes break." (Dániel Berzsenyi: A magyarokhoz. II. 1807.) The great date of this era is 14. July 1789, the beginning of the great French revolution. Its leading principle was enlightenment, and its ideological basis the "glorious intellect".

The prevailing Hungarian conditions of that time are characterized by the economist with the following sentence: "Hungary suffers miserably and even the abundancy of nature cannot help it" (Gergely Berzeviczy).

The irrepressible tide of renascence started from this nadir. Grandiose scientific and literary upswing began. Agriculture also began to develop in these decades. Although farming generally was continued in the same way as centuries earlier, the initials of stabled livestock breeding already appeared, involving fodder plant growing. The way József Fábián saw it in 1819 the spirit of farming rose. In this respect his work was of a pioneering character.

He was born in a family of lesser nobility in Alsóörs (Veszprém county) on 19th February 1761. After finishing the elementary school he studied at the Presbyterian College of Debrecen, where he finished the grammar school in 1779. In 1789 he acquired a "senior" degree teaching meanwhile in the lower forms, among others French language. From Debrecen he went to Switzerland to a study-tour for two years. In 1791—92 he lived in Bern and Zurich, where he had the famous Lavater for his teacher.

After returning home he became the pastor of a Calvinistic congregation of the Balaton highland in Vörösberény. He married Zsuzsanna Somogyi and had four sons and two daughters.

It was in Vörösberény that he started his manyfold important work of common interest. On one hand he was a practical research worker. He set up a small laboratory for natural sciences in a room of the vicarage. In this laboratory, in addition to various smaller and larger globes, simple physical and chemical apparatuses: a magic lantern and the devil of Cartesius,* there was an electric machine, a very rare thing in Hungary at that time. (Benedek Jancsó: Fábián Gábor élete és irodalmi munkássága [Life and literary activity of Gábor Fábián] Arad, 1885. p. 4.) He repeatedly attempted to make grape sugar, and from 1794 on extracted oil from grape seeds, "which practice" — according to his words — "is followed by many by the Lake Balaton".

Books were published by him in succession: translations, revisions and original works too. His first work: "Természeti história a gyermekeknek" (Natural history for children) was published in 1799. In 1803 he wrote an original work: "Természeti tudomány a köznépnek" (Natural science for the commons). In 1805 he translated into Hungarian Chaptal's "little work".

In 1808 he left Vörösberény and went to Tótvázsony to be a pastor; here he lived till his death. During his stay at Tótvázsony he met sad trials: in 1810 he lost his nine-year-old daughter, then in 1815, on 12th June buried his 38-year-old wife "endowed with many virtues", in the cemetery of Tótvázsony. Besides the two grown-up sons his 6-year-old son József and 3-year-old daughter Ágnes remained with him. After a couple of years he married again. His second wife was Zsuzsanna Medgyesi; three children were born from this marriage.

Suffering and sorrow did not, however, break his spiritual strength or take his love of work away. It was in such circumstances that he finished translating one of his big works: "Vizsgálódó és oktató értekezés a szőlőmívelésről" (Study and discussion of vine growing).

* See: notes

His last work was published in 1819: he translated Columella's 12 books on field cropping from Latin into Hungarian.

In the last years of his life he was ill. He comforted and strenghtened himself by translating Ovidius and Cornelius Gallus into Hungarian.

He died in Tótvázsony on 29th January 1825, at the age of 64. This date must be completed by a sentence: He died in the year of foundation of the Hungarian Academy of Sciences and István Széchenyi's appearance. But in his work done for the public he lives among us.

Oeuvre

1. *Természeti história a gyermekeknek* (Natural history for children). This was József Fábián's first work published in 1799. It was the translation of the great work written by György Krisztián Raff, teacher in Göttingen.

When translating he endeavoured to write in a clear, well understandable language and was successful in doing so. When he thought it necessary, he made alterations, and when he considered descriptions of plants or animals not to be quite understandable, he made them clear.

These also suggest that beside the simple language adapted to children, the book has the great merit of possessing a scientific exactness for the sake of the teachers. In fact the "Natural history" is a detailed and systematic botanical, zoological and mineralogical work containing nearly two thousand plants, animals and minerals with their German and Latin names as well. Finally, it gives reference of as many as 43 special works.

József Fábián published this book at private expense, which means that he was one of those who were ready to sacrifice for the public good.

2. *Természeti tudomány a köznépnek* (Natural science for the commons). This original work was published in 1803. It had been written for the purpose of wiping out superstitions of the public opinion. He considered, namely, superstitions to be the most dangerous pest of humanity.

What are then the causes of superstition? He answered: "Its mother is an abysmal ignorance of the things of nature, and a considerable indolence to study them." He knew that he was doing a difficult work, as established beliefs are not easy to wipe out, deep rooting errors to correct.

However, he was not frightened of the difficulties of the task, on the contrary, they stimulated him to an even more thorough and scientific study. He utilized the works of excellent contemporary scientists: Wünsch, Halle, Hube, Pánkel, Fischer and especially Helmuth.

The book is divided into 16 parts. Its method of discussion is from the first to the last scientific and consequent. Its classifications would be worth being taught. Author gives always a definition first, then a teaching, then mentions the superstitions relating to the subject and contradicts them one by one. Finally, if he thinks it necessary, he recites stories, past examples to prove his standpoint. (He did a great service to the succeeding generations if only by recording the superstitions known and practised at that time.)

The way he strived for the intellectual liberation of his nation is proved also by exclamations like these: "This is also a nonsense and nothing else but deception!" "Tremendous absurdity!" "Monstrous foolishness!" "Great unhappiness!" "If any of your trees is fruitless, hoe round the stem and manure it! It is from such work and not from superstition that you can expect results!"

The "Natural science for the commons" is a pioneering work of raising the general level of culture as well. It is not a "dream-book" written in calendar style, but teaches the people up-to-date science in simple, fine Hungarian language and clear manner of presentation.

3. *Vizsgálódó és oktató értekezés a szőlőművelésről* (Study and discussion of vine growing). A translation of works by Chaptal, Rozier, Parmentier and Dussieux, French scientists. This big work was published in two volumes in 1813—14. In the preface author says that this book was especially kindly received by the great French nation. He wonders why nobody has written on the subject in Hungary and examined it by the rules of physics.

It was not an abbreviated copy of the original but the whole big work he published, because in his opinion by getting acquainted with other people's industrious work, customs and scientific findings and comparing them with ours, our knowledge can be "wisely improved". Indeed, seemingly uninteresting sections of this book also contain a lot of teaching. Every specialist may learn a lot from the historical analyses, from the report of the French wine export, and mainly from the explanation why — according to the French scientists — England surpassed France in agriculture in spite of her unfavourable natural conditions.

His remarks given in notes are also highly valuable from a historical point of view. The "Appendix" presents a separate discourse on the production of grape sugar and grape seed oil.

The importance of the book is greatly increased by the 11 copperplates representing grape varieties first in the Hungarian special literature.

4. *Columella XII könyvei a mezei gazdaságról* (Columella's 12 books on field cropping). Both volumes of this work were published in 1819. Author felt that he paid off an old debt by translating this book into Hungarian. In the preface he introduces Columella to the reader. (Lucius Moderatus Columella was one of the noblest Roman economic writers in the first century A.D. He was a high-born, learned man and an expert of economics.)

Author considers such old books as good and useful means, since we can learn from them "what, when and how" the old famous and wise nations did in farming.

Indeed, József Fábián presented us with an almost unknown and invaluable treasure by translating Columella's book from Latin into Hungarian. It is rightly written by the New Hungarian Encyclopaedia that this book is a "valuable source of economic history". But those studying general history, pharmaceutical history or economics will also find this book useful.

Famous sayings and statements of our ancestors are highly valuable in this book. — "Those who know how to till the soil, can and want to do it, will have the best cultivated lands; in other words: one must have skill in his profession, possess the necessary financial means and will to act" (Tremellius). — "Who buys an arable land, must sell his house, lest he will do urban work instead of field work; those who prefer living in towns, will not need a farm" (Poenus Mago). — "Praise the large plot but cultivate a small one !" (Vergilius: Georg. 2: 397. Emphasizing of increasing productivity.)

Minor works

5. *A boroknak termesztésekről, készítésekről és eltartásokról való értekezés* (Dissertation on the production, making and preservation of wines). It is a translation of Chaptal's "little work" published in 1805.

6. *Kenyérsütésről a magyar gazdaasszonyoknak* (To Hungarian housewives on bread baking). This paper was published in 1817 in the Tudományos Gyűjtemény (Scientific Collection). He wrote it for those who did not pay much attention to, or were not skilled in baking bread and so tortured their households and themselves with the most unhealthy bread.

7. *Az ételkeltartás mestersége* (Food preservation). This work was published after his death, in 1833. His son Gábor, the well-known writer and translator, member of the Hungarian Academy of Sciences edited his father's work reconstructed from French.

8. *A mezei gazdaság tudományának rövid summája* (A brief summary of the science of agriculture). A text-book on 150 pages in well readable manuscript, from 1821.

9. *A magyarországi szőlőknek és boroknak históriai ismerete, a nevezetesebb szőlőhegyek leírásával* (History of Hungarian grapes and wines with the description of the more important vineyards). (Author wrote about this collection on 5th May 1809. In the Tudományos Gyűjtemény, 1820. VII. pp 108—120 a report on his work "A szőlőmívelésről" (Vine growing) said that the manuscript is in the editorial office. "This work also would be worth of the protection of a wealthy Maecenas.")

Unfortunately this work has remained unknown up to this day, it would be good to find it in one of the archives!

Evaluation

József Fábián is generally thought to be one of the pioneers of a reasonable scientific agricultural activity. He knew himself that he was doing a pioneer work. In the preface of his very first work he said: "No wonder if I made mistakes, since I was progressing along a path that had been followed earlier but by few."

The basis of his whole work was that he recognized the great use of natural sciences and the importance of their application in practice. So he taught his nation reasonably farming and thoughtful acting.

He translated from German, French and Latin special works giving advices in scientific farming. E.g. he said about the book "A szőlőmívelésről" (Vine growing) that it did not follow the customs blindly, but taught everything according to experience and the laws of physics.

He translated Columella's book, because he was on the same opinion as we are, namely, that in farming the will and talent without knowledge may cause great damages, as unreasonable operations result in superfluous costs.

We feel we have a good right to say that József Fábián gave his readers a valuable, good material in his translations and original works.

And not only did he a good work but also did it in a good form. He is recorded not only as an excellent natural scientist but also as a good scholar of Hungarian language.

His standpoint as a translator should not be neglected even today. 1. He used every effort to translate in a clear, well understandable language. For this very purpose he translated thoughts rather than words. 2. He still stuck — as much as possible — to the "text" in order to keep the "spirit and manner" of the era, as in his opinion it is indispensable when translating an old book, it is like a seal on a certificate.

When reading either his translations or his original works we find he wrote simply and still exquisitely. He consciously took care of his expressions. Idiomatic words and expressions made by himself gave a special genuineness to his language. Mountains vomiting flames, wandering stars, thunder leaders, airy appearances, angry wind — are some fine examples of them.

On the basis of his work we know him as a man of universal interest and universal knowledge. He wanted to know everything because he wanted to teach everything to his nation. That is why he recommended two ways of fire-fighting, gave precise descriptions of medicines cows could be cured with. That is why he wrote dissertations on bread baking, washing and blanching, on food preservation, and criticized unreasonable anxieties observed in cases of unusual weather conditions and hocus-pocus prescribed by the calendars. He told that a medicine for eyes had once been made of the fat of vipers, and that it was thought that the meloe (Meloe proscarabeus) had a fluid that was a good remedy for the bite of a mad dog.

He never gave mere abstractions and theories, but always practical knowledge immediately applied to either deep ploughing or adequate feeding or sick-nursing. In one word, he gave advices for a more human, free and happy life. He did all these because he loved people. His heart was filled with "love for the public good".

We understand it and think it right that the Tudományos Gyűjtemény in its necrologue called him "a torchbearer of Hungary" who taught necessary and useful knowledge to his nation.

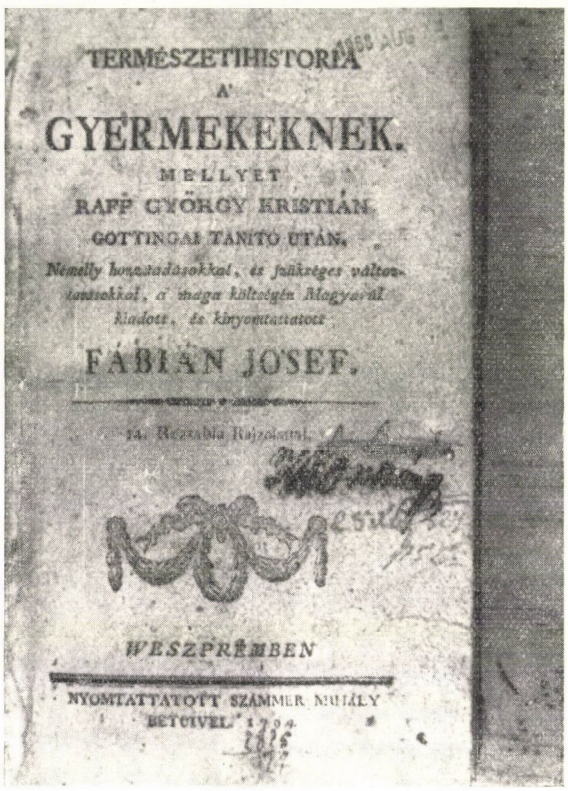
P. HARGITA

Magic lantern

A projecting apparatus by means of which transparent pictures painted on glass can be projected to a screen. It was a precursor of modern projection. Today it is out-of-date and used only as a children's toy. (Új Magyar Lexikon [New Hungarian Encyclopaedia].)

The devil of Cartesius

They are small empty glass figures with tiny holes on the side of their bellies and two horns on the head; they are somewhat lighter than water. They are named after Cartesius because it was he who first made them, and were called devils since they usually have the same form as devils are illustrated in. (A Köznépnek [To the commons], p. 67.)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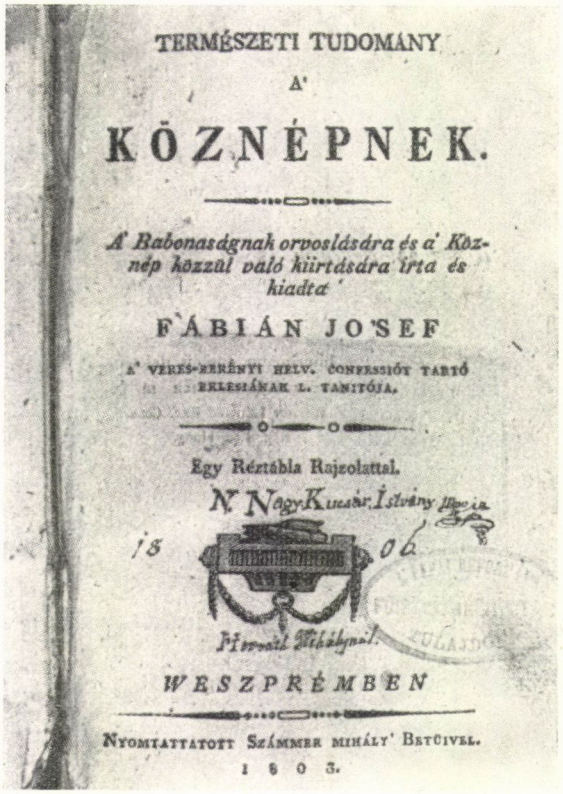
GYERMEKEKNEK.
MELLYET
RAFF GYÖRGY KRISTIÁN
GOTTINGAI TANITÓ UTÁN,
Némelly hozzátadásokkal, és javításos változtatásokkal, a' maga költségén Magyarúl
kiadott, és kinyomtattatott
FÁBIÁN JÓSEF.
14. Rezetsbla Rajzolattal.
WESZPRÉMBEN
NYOMTATTATOTT SZÁMMER MIHÁLY
BETŰIVEL. 1792.

Fig. 1



TERMÉSZETI TUDOMÁNY
A'
KÖZNÉPNEK.

A' Babonaságnak orvoslására és a' Köznép közzül való kiirtására írta és kiadta

FÁBIÁN JOSEF

A' VERES-BERÉNYI HELV. CONFESSIÓT TARTÓ ECCLESIÁNAK L. TANITÓJA.

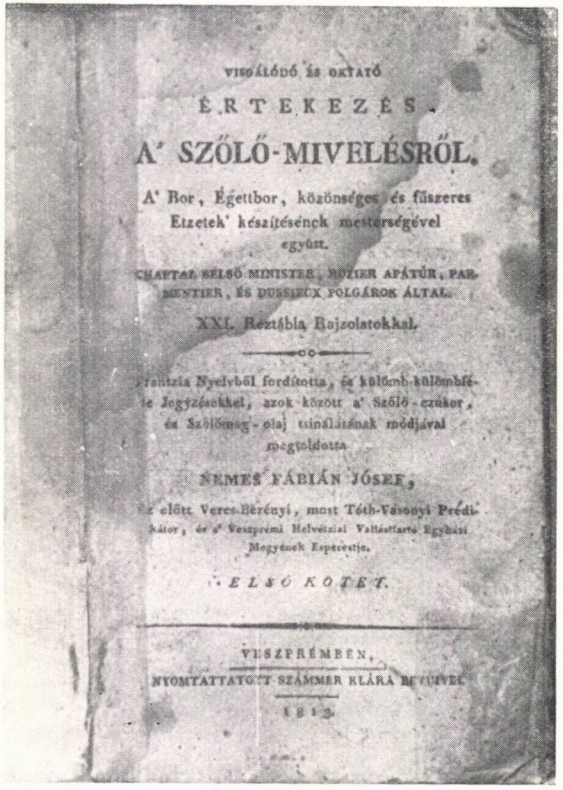
Egy Réztábla Rajzolattal.

WESZPRÉMBEN

NYOMTATTATOTT SZÁMMER MIHÁLY' BETŰIVEL.

1803.

Fig. 2



VISSZÁLÓDÓ ÉS OKTATÓ

ÉRTEKEZÉS

A' SZŐLŐ-MIVELÉSRŐL.

A' Bor, Égettbor, közönséges és fűszeres Etzetek' készítésének mesterségével együtt.

CHAPTAL BELSŐ MINISTER, ROZIER APÁTÚR, PARMENTIER, ÉS DUSSIEUX POLGÁROK ÁLTAL.

XXI. Réztábla Rajzolatokkal.

FRANCZIA NYELVBŐL FORDÍTOTTA, ÉS KÜLÖMB-KÜLÖMBFÉLE JEGYZÉSEKKEL, AZOK KÖZÖTT A' SZŐLŐ-CZUKOR, ÉS SZŐLŐMAG-OLAJ TSINÁLÁSÁNAK MÓDJÁVAL MEGTOLDOTTA

NEMES FÁBIÁN JÓSEF,

ez előtt Veres-Berényi, most Téth-Vásonyi Prédikátor, és a' Veszprémi Helvétziai Vallástartó Egyházi Megyének Esperestje.

ELSŐ KÖTET.

VESZPRÉMBEN,

NYOMTATTATOTT SZÁMMER KLÁRA BETŰIVEL.

1813.

Fig. 3

Acta Agronomica Academiae Scientiarum Hungaricae 19, 1970

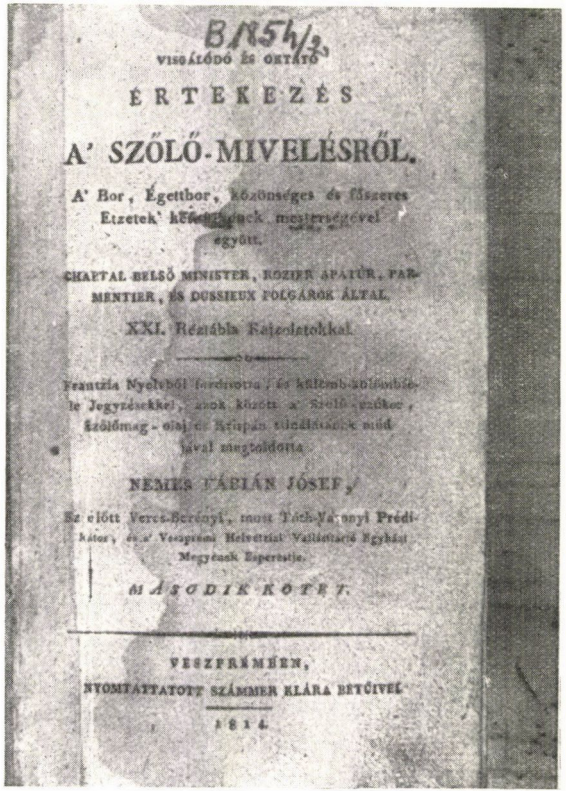


Fig. 4

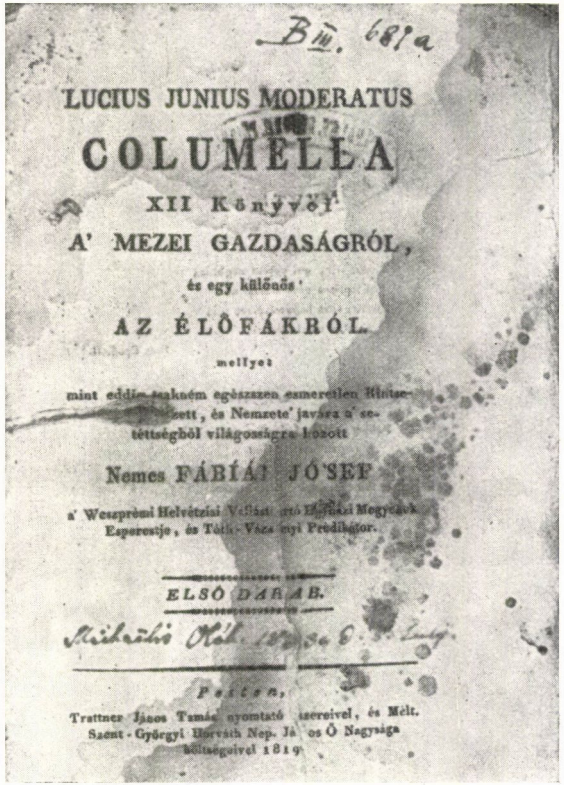


Fig. 5

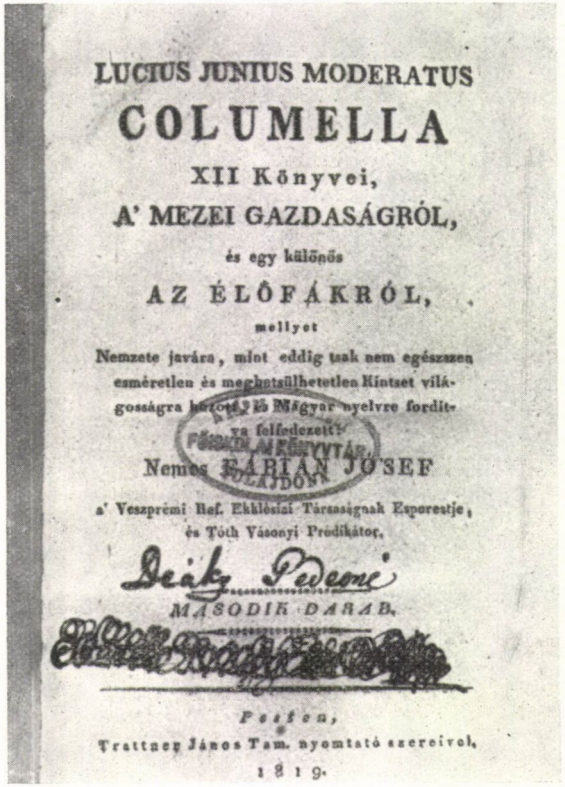


Fig. 6

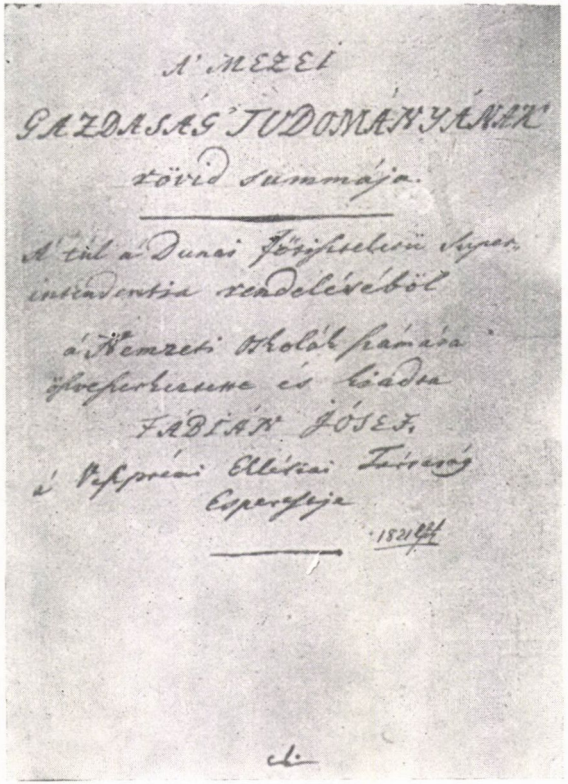


Fig. 7

Figs. 1—7. The title pages of Fábián József's books

CHEMICAL CONTROL OF THE EARLY AND LATE BLIGHTS ON TOMATO

As the tomato plant is attacked by various diseases and insects in the U.A.R., an attempt was made for the control of *P. infestans* using the fungicides Cupravit, Mancozeb, and Zineb.

Blights were responsible for an estimated loss of about one million Egyptian pounds during 1954 season (HAMMAD *et al.* 1965). This disease caused about 50 per cent loss of tomatoes in the winter of 1962 planting, and 15 to 20 per cent in the fall and summer plantings (THABIT *et al.* 1966).

Table 1

Mean of number of infested tomato fruits

Treatment	X
Untreated	70.25
Cupravit	45.25
Mancozeb	34.75
Zineb	39.75

L.S.D. Treatments at t 0.05 = 9.55

Table 2

Mean of weight (kg) of uninfested tomato fruits

Treatment	X
Untreated	30.25
Cupravit	38.50
Mancozeb	40.00
Zineb	39.00

L.S.D. Treatments at t 0.05 = 6.68

Fungicides have been used successfully to control the *P. infestans* and other fungi on tomatoes and other vegetables.

Applications were carried out by a knapsack Saval sprayer using

1. Cupravit 25 per cent W.P. at the rate of 0.5 per cent;
2. Mancozeb 80 per cent W.P. at the rate of 0.25 per cent;
3. Zineb 72 per cent W.P. at the rate of 0.25 per cent.

The treatments were made at intervals of 10 days for the dithiocarbamates and at 15 days for Cupravit. The application dates of Dithane were: 10/2, 21/2, 3/3, 13/3, 23/3 and 2/4, while they were for Cupravit: 10/2, 26/2, 13/3 and 28/3.

The experiment was performed at the Alexandria University Experiment Station during the winter planting. Tomato seeds were mixed with Orthocid 75 at the rate of 8 grams per kilogram seed. Seeds were sown in wooden flats ($50 \times 35 \times 10$ cm) containing a mixture of clay and sand, in November. 60 days after the planting the plants were transplanted in the field. The experiment was performed in completely randomized block designs with four replications. The plot consisted of three rows each four meters long and 1 meter apart. The spacing was 40 cm between the plants. Plots were separated from each other by guard rows.

The number of infected fruits in each plot was recorded. The fruit was considered infected if a single lesion was present, no matter how small or large. The weight of uninfected fruits was recorded as kilograms per plot.

The results of the field trials are statistically analyzed to evaluate the effect of the different fungicides on *P. infestans*. These results are summarized in Tables 1 and 2.

All treatments gave a significantly good result in protecting the fruits. The effect of Mancozeb was significantly better than that of Cupravit, but not significantly better than that of Zineb. There were no significant differences between Cupravit and Zineb. Though Mancozeb and Zineb protected the fruits sufficiently, their effect could be even increased when shortening the spray intervals to seven days instead of ten (leaching by rain the protective effect decreased).

The plants treated three times gave yields significantly better than the untreated ones, but there were no significant differences between them.

Mancozeb showed the best results against *P. infestans*, which agree with the results obtained by LEHMANN *et al.* (1962) and SARJAS (1963).

The average increase in tomato yield was approximately 30 per cent for the three fungicides, which proves that the application of any of the three as protective sprays on tomatoes will definitely raise the output.

*

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REFERENCES

HAMMAD, S. M.—ELAROSI, H.—ASEM, M. A. (1965): Pests of vegetables and their control. National Printing and Pub. Co., 766.

LEHMANN, H.—GREWE, F.—LAUTEMSCHLAGER, W. (1962): Farbenfabriken Bayer A.G. Ger. Appl., 8.

SARJAS, P. DE (1963): Mancozeb, a new dithiocarbamate. Mededel. Landbowwhogeschod Opzoekingssta.

THABIT, K. A.—RAGAB, M. M.—SHAHIDI, A. A.—FAHIM, M. M. (1966): Text-book of plant pathology. Sciences Pub. Co. Sect. Edit., **120**, 412.

ORGANIZATION OF APPARENT AND TRUE INFERIOR PISTILS

On the basis of morphological and histological studies, the organization of inferior pistils was in the past and is still the subject of wide discussions. In the controversy of the two opinions — apparent inferior pistil (DE CANDOLLE 1827, VAN TIEGHEM 1868, EAMES 1961) and true inferior pistil (NAUDIN 1855, DECAISNE 1857, GOEBEL 1866, TROLL 1954) — the early morphological, then later the histological and histogenetical studies seemed to support sometimes one, sometimes the other opinion. Opinions even about the same family often differed,

e.g. pistils of *Compositae* were described now as axial (BUCHENAU 1872, STEBBINS 1940, GRACZA 1966), now as of apparent inferior position (DUCHARTRE 1841, MARTIN 1892, SNOW 1945, KASAPLIGIL 1951). Similarly, the pistil organization of *Umbelliferae* already accepted for appendicular (VAN TIEGHEM 1868, KADEN—TIHOMIROV 1954, SÁRKÁNY 1962, KOVÁCS—SÁRKÁNY 1968) was earlier considered by some authors to be of axial origin (SCHLEIDEN 1839, PAYER 1857, TAMANSCHJAN 1948).

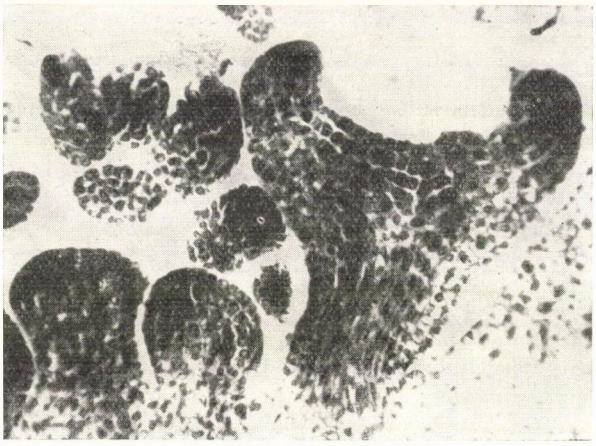

Fig. 1. Flower primordium of *Petroselinum hortense* (obj. 40×, oc. 5×)

Present paper gives an account of some recent observations concerning the pistil organization of two and three species in the two families mentioned: *Petroselinum hortense* Hoffm., *Pastinaca sativa* L. and *Foeniculum vulgare* Mill. from the family *Umbelliferae*, and *Helianthus annuus* L. and *Calendula officinalis* L. from the family *Compositae*.

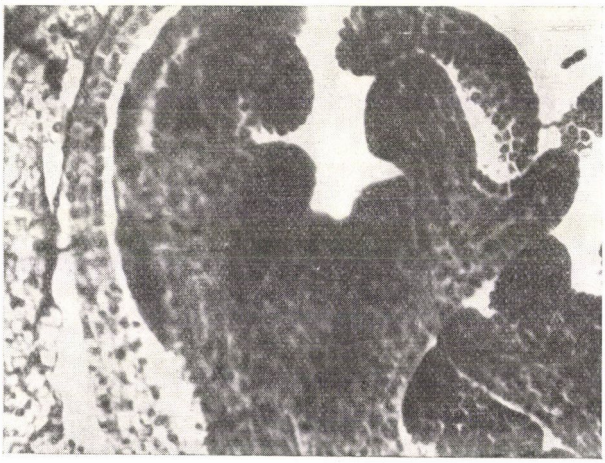

Fig. 2. Flower primordium of *Pastinaca sativa*, with petal and stamen primordia (obj. 10×, oc. 5×)

Developing inflorescences and flowers of the five species were fixed in Bouin's fixative, then after the usual embedment in paraffine section series were made with a microtome, and during the microscopic examination the characteristic developmental stages were recorded on photomicrographs.

Examinations were started with undivided flower primordia of primordial inflorescences. Longitudinal sections of flower primordia of the apparent inferior pistilled *Petroselinum*,

Fig. 3. Part of a *Helianthus annuus* young inflorescence with flower primordia. (Obj. 20×, oc. 5×)

Pastinaca and *Foeniculum* seem to be triangular. The flower primordium, which has a rather wide surface, is attached to the floral axis by its narrowing basal part. On the other hand, flower primordia of the axially organized *Helianthus* and *Calendula* do not grow narrow toward the floral axis, but show almost equal diameters at the apex and at the base too (Figs. 1, 3).

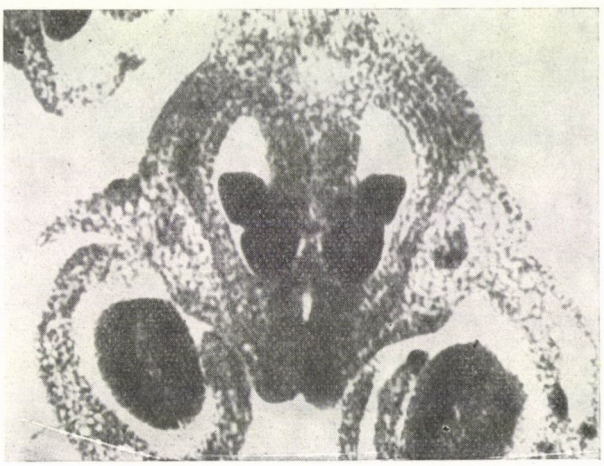

Fig. 4. Flower primordium of *Helianthus annuus* after the appearance of petal, stamen and pistil primordia. In the receptacle part the meristemic zone begins to show up. (Obj. 20×, oc. 5×)

It is characteristic of all species examined both in *Umbelliferae* and *Compositae* that the initially hemispherical flower primordia show an increased growth on the peripheral part due to the more intensive activity of the bordering meristems, and thus gradually become of flattened surface. In this state, at the narrower basal part of the flower primordia of *Petroselinum*, *Pastinaca* and *Foeniculum* the intensity of cell-division decreases, and only the widening region (near the surface) remains meristemic. On the other hand, in *Helianthus* and *Calendula*

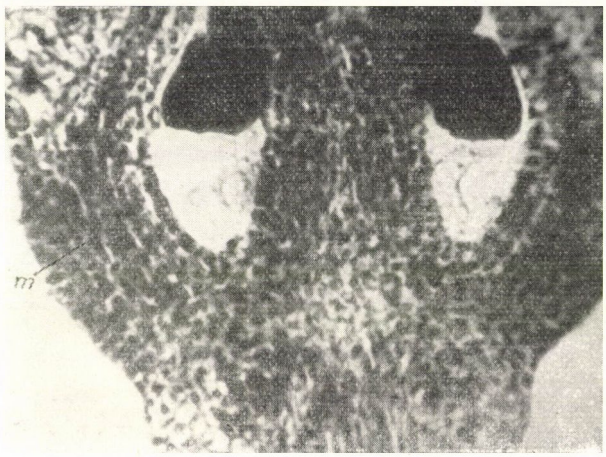

Fig. 5. Part of a *Helianthus annuus* young inflorescence with flower primordia. In the centre of the receptacle a meristemic zone (m) is left. (Obj. 10×, oc. 5×)

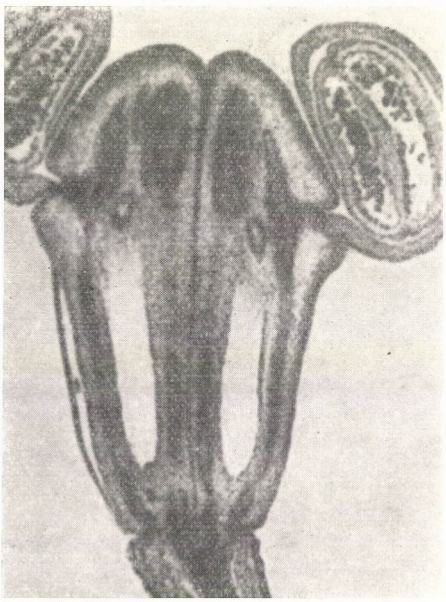

Fig. 6. Fully developed flower of *Helianthus annuus* with a meristemic zone (m) still active. (Obj. 10×, oc. 5×)

flower primordia of nearly the same age a meristem, fairly homogeneous as regards intensity, functions.

In the case of all five plants first the petal primordia initiate on the surface of the flattened flower primordia, then the stamen and carpel primordia appear centripetally. Calyx primordia develop only on the flower primordium of *Helianthus annuus* L., and in a rather reduced form, long after the pistil primordia have appeared.

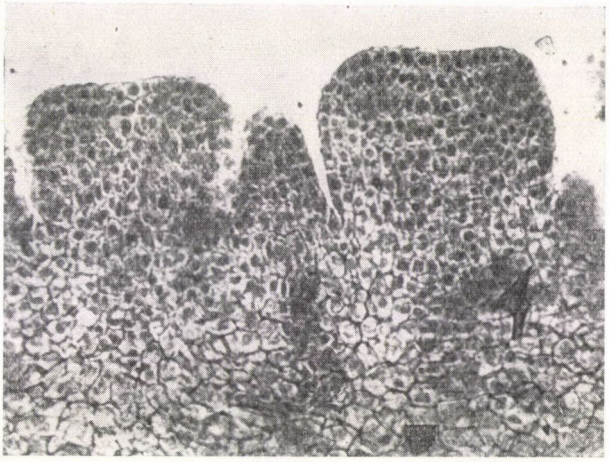

Fig. 7. Flower primordium of *Calendula officinalis* with a meristemic zone (m) in the receptacle part. (Obj. 20×, oc. 5×)

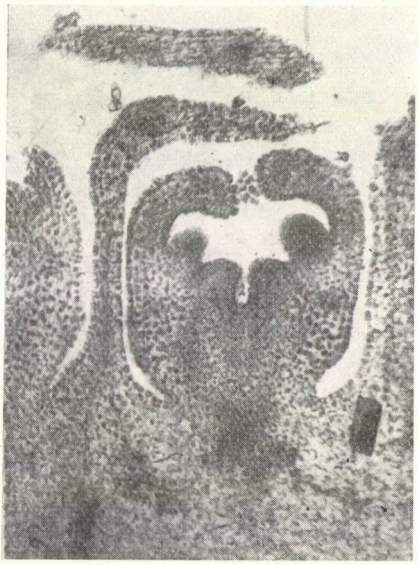

Fig. 8. Fully developed flowers of *Calendula officinalis* with meristemic zones still seen. (Obj. 5×, oc. 5×)

Simultaneously with the development of floral leaf primordia — but later too — the receptacle parts in the flower primordia of *Helianthus* and *Calendula* were found to grow not only longitudinally but also in diameter due to the meristems persisting in the middle of this region (Figs. 4, 7).

On the other hand, in the flower primordia of *Petroselinum*, *Foeniculum* and *Pastinaca*, the receptacle cells are early vacuolized and this process continues in the course of flower development. The minor increase in the volume of the receptacle is caused primarily by cell elongation. At the same time, the developing floral leaf primordia (petal, stamen, pistil) grow congenitally together at the base, which is also proved by the uniform development of the bundle-like procambium-system in the ovary wall coalescent with petals and stamina (Fig. 2).

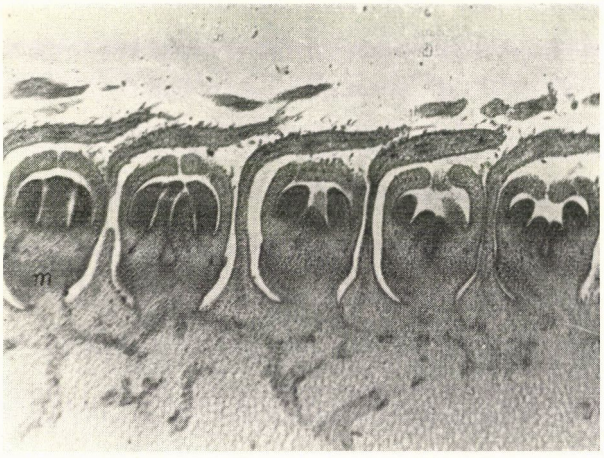

Fig. 9. Flower primordium of *Petroselinum hortense* at the plicatio stage of carpels. A highly meristemic zone (m) in the wall of the young pistil. (Obj. 10×, oc. 5×)

At the next development stage the elongation of flower primordia increases. In the basal part of the receptacle — which has grown more intensively in case of *Helianthus* and *Calendula* —, as well as in the zone below the floral leaves, cells begin to become stable, while in the central part a readily stainable meristemic zone located transversally at the level of the ovary is left behind and results in a further increase in receptacle tissues, thus making possible the simultaneous growth of this tissue region with the developing ovary. The partial meristemic nature of the receptacle part persisting up to the end of the pistil development provides an explanation for the organization of the true inferior pistil. In addition, in the case of the two species (Figs. 5, 6, 8), the differentiation process of vascular bundles, the presence of recurrent bundles and the position of the nodal level can be mentioned (GRACZA 1966).

On the other hand, flower primordia of *Umbelliferae* species examined are characterized by an advanced phase of stabilization of cells in the receptacle and in the upper zone of the young floral leaves, while the apical parts of the convergent carpel primordia still show meristemic characteristics. A similar intensive meristemic activity can be found in the ovary wall, which is joined with the basal part of petals and stamina, resulting in the simultaneous development and uniform tissue structure of the three regions; this partly explains the development of the apparent inferior pistil (Figs. 9, 10, 11, 12), which is confirmed by the complex organization of the vascular bundles and the position of the real nodal level too (SÁRKÁNY 1962).

When summarizing the results of examinations the first thing to be emphasized is that in case of *Helianthus annuus* L. and *Calendula officinalis* L. in the developing flower the

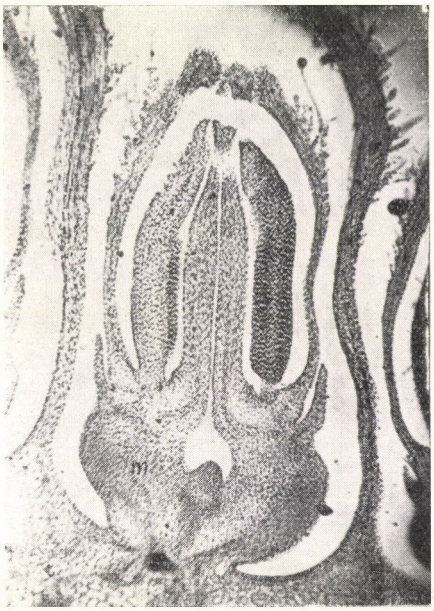

Fig. 10. In fully developed *Petroselinum hortense* flowers at the basal zone of petals and stamina jained with the ovary wall an active meristemic zone still can be found. (Obj. 10×, oc. 5×)

Fig. 11. Ovary part of *Pastinaca sativa* pistil with the meristemic zone (m). (Obj. 20×, oc. 5×)

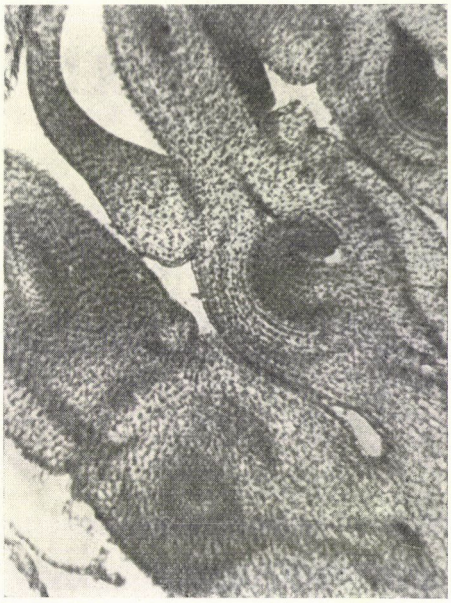

Fig. 12. Longitudinal section of fully developed *Foeniculum vulgare* flower. (Obj. 10×, oc. 5×)

medial level of the receptacle — which provides for the further growth of receptacle tissues — shows the highest meristemic activity; so this region keeps space with the growth of the ovary, they even join together from the beginning, giving thus a complementary explanation for the development of the true inferior ovary. — In the flowers of *Petroselinum hortense* Hoffm., *Pastinaca sativa* L. and *Foeniculum vulgare* Mill. it is above the slowly developing receptacle, in a part of the floral leaves (petals, stamina and carpels) adjacent to the receptacle, that a more active meristemic zone can be observed, the activity of which results in carpels and other floral leaves joining together, and a uniform tissue structure developing. Recognition of the two types of meristemic zone provides further data on the organization of apparent and true inferior pistils.

*

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P. Gracza, S. Sárkány

REFERENCES

Buchenau, F. (1872): Über Blütenentwicklung bei den Compositen. Bot. Zeit., **30,** 305—319, 329—332, 353—370.

De Candolle, A. (1827): Organographie végétale. **1,** Paris.

Decaisne, J. (1857): Note sur l'organogénie floral du poirier. Bull. Soc. Bot. France, **4,** 338—342.

Duchartre, P. (1941): Observation sur quelques de la fleur dans le *Dipsacus silvestris* Mill. et dans l'*Helianthus annuus* L. Lin. Ann. Sci. Nat. II. Bot., **16,** 221—236.

Eames, A. J. (1961): Morphology of the Angiosperms. McGraw-Hill Book Company, Inc. New York—London—Toronto.

Goebel, K. (1886): Zur. Entwicklungsgeschichte des unterständigen Fruchtknotens. Bot. Zeit., **44,** 729—738

Gracza, P. (1966): Organisationsverhältnisse des Gynäzeums der Sonnenblume. Annales Univ. Sci. Budapestiensis de Rol. Eötvös Nom., **8,** 97—105.

Kaden, N. N.—Tihomirov, V. N. (1954): Zum Problem der Morphologie des Fruchtknotens und der Frucht der Doldenblütler. Bjull. Moskov. Obsc. Ispyt. Prir. Otdel. Biol., **59,** 79—83.

Kasapligil, B. (1951): Morphological and ontogenetic studies of *Umbellaria californica* Nutt. and *Laurus nobilis* L. Univ. Calif. Bull. Bot., **25,** 115—240.

Kovács, A.—Sárkány, S. (1968): Some observation on pistil organisation of *Heracleum mantegazzianum* (Somm. et Lev.). Acta Agronomica Acad. Sci. Hung., **17,** 47—57.

Martin, G. W. (1892): Development of the flower and embryo-sac in *Aster* and *Solidago*. Bot. Gaz., **17,** 653—658.

Naudin, C. (1855): Observations relatives à la nature des vrilles et à la structure de la fleur chez les Cucurbitacées. Ann. Sci. Nat. IV. Bot., **4,** 5—19.

Payer, J. B. (1857): Éléments de botanique. Librairie de Victor Masson, Paris.

Sárkány, S. (1962): Organisation des Stempels und der Spaltfrucht von *Foeniculum vulgare* Mill. und die Frage des sogenannten unterständigen Fruchtknotens. Ann. Univ. Sci. Budapestiensis de Rol. Eötvös Nom., **5,** 193—224.

Schleiden, J. H. (1839): Sur la signification morphologique du placentaire. Ann. Sci. Nat. II. Bot., **12,** 373—376.

Snow, E. (1945): Floral morphology of *Chrysothamnus nauscosus* speciosus. Bot. Gaz., **106,** 451—462.

Stebbins, G. L. (1940): The Cichoriare Mem. Torrey Bot. Club, **19,** 5—76.

Tamanschjan, S. G. (1948): Die sekundäre Hypogenie der Blüte von Doldenblütlern und das Prinzip ihrer Funktionsveränderung (Russ) SSSR., **61,** 537—540.

Troll, W. (1954): Praktische Einführung in die Pflanzenmorphologie I. Gustav-Fischer-Verlag, Jena.

Van Tieghem, P. (1868): Recherches sur la structure du pistil. Ann. Sci. Bot. France, **16,** 412—420.

ROLE PLAYED BY THE CONTACT RECEPTORS OF ANTENNAE IN THE EGG LAYING PROCESS OF CEUTHORRHYNCHUS MACULA-ALBA HERBST. (COLEOPTERA: CURCULIONIDAE)

Literature dealing with the biology of *C. macula-alba* (SZELÉNYI 1935, 1939; ZSOÁR 1950, SCHRÖDTER—NOLTE 1952, MANOLACHE *et al.* 1961, REICHART 1961, SZÜCS 1962, SÁRINGER—ZSOÁR 1963, SÁRINGER 1964, 1970) gives no data on the ethology of egg laying.

Investigations made in the last years on the ethology of egg laying revealed that on the verge of laying eggs females move their antennae intensively and pass them many times downward over the capsule wall. On the basis of this observation the hypothesis of antennae playing a decisive role in choosing the place of egg laying has been set. In other words, contact receptors by means of which the females choose a place suitable for egg laying have to be located on the antennae.

Antennae of *C. macula-alba* consist of 10 segments (1 basal segment known as the scape, 6 segments of the pedicel and 3 segments of the flagellum or clavola, geniculate-clavate). It is a question whether segments are equivalent when choosing the place of egg laying. This question has been decided by two methods used. In one of them segment groups of antennae (scape, pedicel, flagellum) were gradually removed, while in the other they were covered with thick black Indian ink. The latter method was at the same time control of the former one. Namely, amputation is a relatively drastic intervention, may even have a harmful effect; this possible negative effect was to be eliminated in imagos that were not mutilated only prevented to use their antennae.

In the course of a preliminary study of mere informatory character segments were gradually removed and covered respectively, first the 3 segments of the flagellum, then those of the pedicel and finally the whole antenna. Imagos thus prepared — 4—7 specimens per

Table 1

Egg production of C. macula-alba under various antenna treatments

Treatment	Number of eggs (after 24 hours)		Number of females	Cibatio
	in the capsule	on the surface of the capsule		
I. Flagellum segments removed ...	4	1	4	+++*
Flagellum segments stained	6	3	5	++
Control	7	—	5	+++
II. Flagellum segments + 6 pedicel segments removed	3	—	5	++
Flagellum segments + 6 pedicel segments stained	4	1	6	++
Control	9	—	7	+++
III. Entire antenna removed	—	—	6	++
Entire antenna stained	—	1	6	+++
Control	11	1	6	+++

* +++ = intensive cibatio
++ = medium cibatio

treatment — were placed onto 1—2 days old poppy capsules. From the same population untreated imagos of the same age were parallelly kept under observation on similarly old poppy capsules. The treatments were evaluated after 24 hours. Results are presented in Table 1.

According to the data of Table 1, examinations performed parallelly on populations treated with the two methods mentioned and on a control population prove that female imagos are able to choose the place of egg laying even with only the basal segment left of the antenna. This means that contact receptors ensuring the ability of choosing the place of egg-laying are present on the first antenna segment (scape) already. Further investigations are required to clarify the egg-laying ethologic role of the individual mouthpart.

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REFERENCES

MANOLACHE, P.—IGNATESCU, I.—KOLOSY, E.—GHIUTA, M.—TITZ, M. (1961): Recherches sur la biologie et la lutte contre le charançon des capsules de pavot *(Ceuthorrhynchus macula-alba* Herbst.). Inst. Centr. Cercet. Agricol. Anale, 29, C, 163—176.

REICHART, G. (1961): A máktokbarkó elleni védekezés tanulságai (Experiences of poppy-weevil control). Magyar Mezőgazdaság, **27,** 14—15.

SÁRINGER, GY. (1964): Der Wintermohn und die Mohnschädlinge. Ann. Inst. Prot. Plant. Hung., **9,** 185—194.

SÁRINGER, GY. (1970): A *Ceuthorrhynchus macula-alba* Herbst. biológiája Magyarországon I. Az imágók tavaszi előjövetele és rajzásmenete (Biology of *Ceuthorrhynchus macula-alba* Herbst. in Hungary I. Spring appearance and swarming of imagos). Acta Phytopathologica Acad. Sci. Hung., (in press).

SÁRINGER, GY.—ZSOÁR, K. (1963): A máktok-ormányos elleni védekezés (Poppy-weevil control). Magyar Mezőgazdaság, **25,** 12—13.

SCHRÖDTER, H.—NOLTE, H. W. (1952): Freilanduntersuchungen über den Einfluß der Temperatur auf Eiablage und Larvenentwicklung des Mohnkapselrüßlers Ceuthorrhynchus macula-alba. Nachrbl. Deutsch. Pflanzenschutzdst., N. F., **6,** 67—72.

SZELÉNYI, G. (1935): Some observations from the life history of the poppy-weevil, *Ceuthorrhynchus macula-alba* Herbst. Kísérletügyi Közlemények, **5—6,** 217—224.

SZELÉNYI, G. (1939): Die Schädlinge des Ölmohns in Ungarn. Vehr. 7. Intern. Kongr. Entom., Berlin, **4,** 2625—2639.

SZÜCS, J. (1962): Máktokbarkó *(Ceuthorrhynchus macula-alba* Herbst.) vizsgálatok eredményei [Results of poppy-weevil *(Ceuthorrhynchus macula-alba* Herbst.) investigations]. A növényvédelem időszerű kérdései, **1,** 49—54.

ZSOÁR, K. (1950): Adatok a máktokbarkó *(Ceuthorrhynchus macula-alba* Herbst) biológiájához [Data on the biology of poppy-weevil *(Ceuthorrhynchus macula-alba* Herbst.)]. Agrtud. Egyet. Mezőgazd. Kar Évkönyve, **1,** 130—136.

MICROMORPHOLOGICAL METHOD OF DETERMINING THE OPTIMUM DEPTH OF PLACING ORGANIC MANURE IN SANDY SOILS

The amelioration of loose, well aerated rust-coloured forest soils with sandy texture and — at least periodically — intense biodynamics depending on the moisture content, as well as that of cultivated blown sands and desert-dunes, etc. is one of the most difficult tasks of agriculture. Egerszegi's so called "deep layering system of manuring" (EGERSZEGI 1958) produces artificial horizons with the organic matter (manure, peat, etc.) placed in the soil,

as it is concentrated in one or more continuous horizontal layers deep under the surface (30—70 cm). In this way organic matter is prevented for a long time from a rapid aerobic bacterial decomposition which may result a considerable loss of nutrients on one hand, and its slow, continuous and hereby very economical utilization by roots penetrating deep into the soil is ensured, on the other (SZABÓ—EGERSZEGI 1969). One of the most important tasks of the deep layering system of manuring is to determine the rational depth of placing the manure layers. Rapid and almost complete mineralization in the surface soil, and slow — or no — decomposition of organic matter at a certain depth are general characteristics of moderately calcareous sandy soils in the temperate and warm climatic zones. Between these two extremities a wide range of decomposition processes of different intensity can be found depending on the depth of the soil. In principle, the properly chosen depth of manure placing should be identical with the horizon where transformation of organic matters into available nutrients provides a maximum possibility of utilization for the plants. This statement is valid even if increase in yield is to be achieved by fertilization in these soils too, and manure is applied primarily in order to obtain a stimulating effect on the growth of plants (by increasing cell permeability, accelerating of respiratory processes, by hormone growth action, etc.). This so called optimum depth should be determined in the individual farms with the given climatic and soil conditions taken into consideration. Unfortunately, agricultural practice has not possessed any exact methods to solve this task as yet. During the micromorphological detection of dynamics in organic matter transformation the subsequent method of determining the proper depth of manuring was elaborated.

On the basis of direct microscopic observations and studies on soil thin-sections produced with unsaturated polyester cast resin three micromorphologically well characterized distinct depth zones were found from the surface of horizon A to horizon C of sandy soils:

1. The "zone of biodegradation" which extends to a depth of about 15—20 cm can be characterized by the rapid decay of plant and animal tissue elements introduced into the soil, a complete elimination of microscopic cellular structures observed after several months already. At the same time, transformation of organic matter into colloidal humus is of minor quantity, and the duration of the new organic (humus-) cutan appearing around the sand grains and that of the intergranular humus plasma of low polymerization degree is short and they are quickly decomposed by aerobic bacteria.

2. In general, below 20 cm to a depth of about 50 cm conversion of the fresh organic matter into colloidal humus is high and also of considerable quantity, and stability of the dark cloud-like amorphous humus produced can be detected micromorphologically as well. In this "accumulation zone of humus colloids" a peculiar inversion layer can be distinguished. This inversion layer corresponds to a soil depth where the extent of colloidal humus transformation from the original structured organic matter — under conditions characteristic of the soil — is maximum. The inversion layer can be easily recognized at the microscopic examination of the soil thin sections, as here the accumulated dark amorphous humus occupies relatively the largest surface in the field of vision. From the inversion layer to the biodegradation zone upwards the extent of humus conversion gradually decreases due to the increasing biological activity. Below the inversion layer the conversion also decreases due, however, to an increasing accumulation of intact or slightly altered (undigested) organic residues. Insufficient transformation of organic remnants below 50 cm is generally of such an extent that in this case a third distinct zone of depth can be spoken of.

3. "Accumulation zone of undecomposed organic residues." The deeper the place of deposition the more possible — even after decades — the histological determination of plant tissue elements occurring in this zone. Colloidal humus produced in this zone forms either cutan on the organic and inorganic skeleton elements or distinct microaggregates in the pore space, and its quantity — though relatively low — is very stable, because here not only the

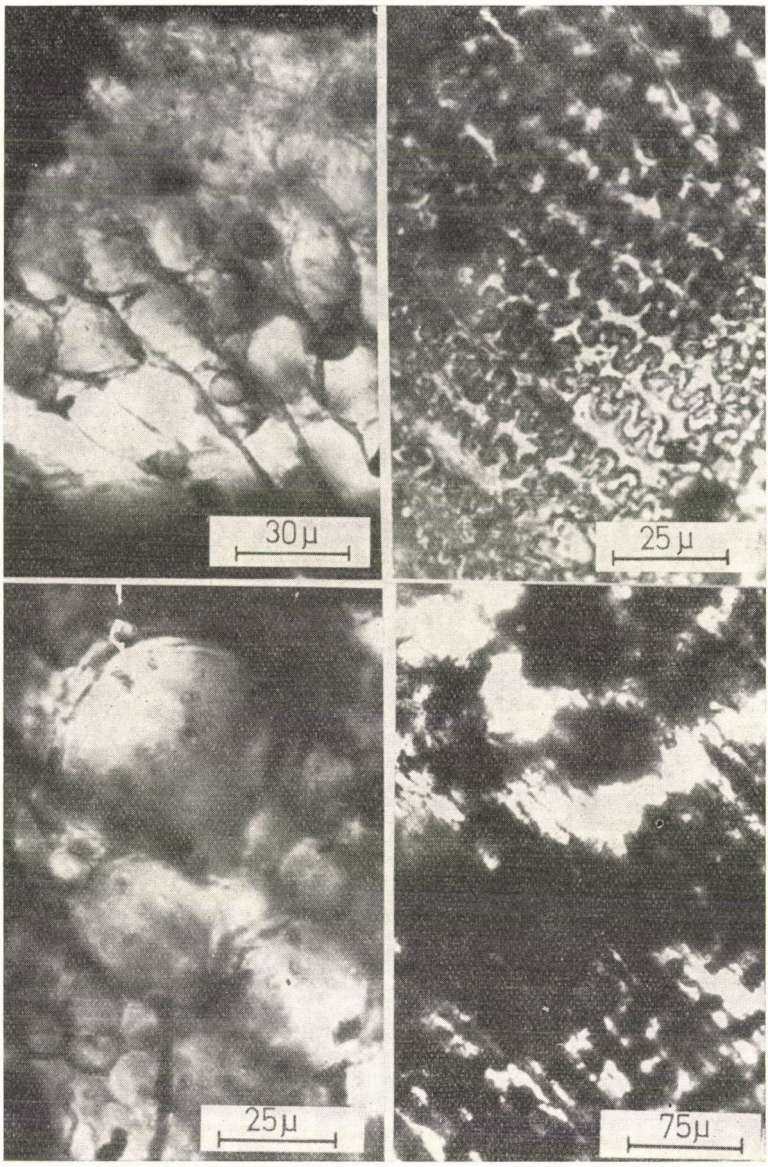

Fig. 1. (a—d) Undecomposed organic residues preserving the original microstructure of plant tissue elements (medullary parenchyma, epidermis cells with undulate walls, xylem and sclerenchyma remains); obtained from a manure layer 14 years after the deposition at a depth of 62 cm. Soil thin-sections. Őrszentmiklós

breakdown of polyaromatic compounds but also the decomposition of the cellulose in the cell walls are permanently hindered.

The boundaries of these zones are — of course — not sharp, transition is gradual. Knowledge of their dynamics is indispensable for the determination of the necessary depth

of manuring. This zonality depends, in fact, on aeration. With the increase of soil depth activities of microaerophilic, facultative and obligate anaerobic bacteria (mainly bacilli) become dominant. The scope of their mineralizing activity becomes downwards more and more restricted to readily degradable elements of the deposited organic matter. Protein, carbohydrate (with the exception of cellulose), free amino acid, etc. fractions of manure layer established in the "accumulation zone of undecomposed organic residues" are mineralized in the first year with

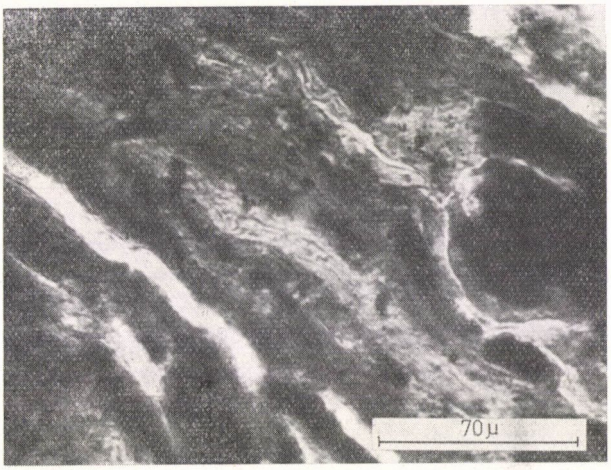

Fig. 2. Characteristic habitus of compact colloidal amorphous humus with secondary layers, accumulated locally at the place of transformation, as shown in thin-section. From a manure layer 6 years after the deposition at a depth of 35 cm. Soil thin-section. Őrszentmiklós

a sudden intensity by the microorganisms, while organic nitrogen is converted by them mainly into ammonia-N (KLIMES-SZMIK 1955). Latter is a direct consequence of dominant microaerophilic or anaerobic conditions which can partly be attributed to the extremely unfavourable aeration of this zone. Bacterial activity becomes stabilized subsequently at a very low level which — as shown by Fig. 1 — may spare the cellular structures for as long as fifteen years. The root systems of cultivated plants penetrate the fresh manure layer even at a depth of 80 or 100 cm; after an initial nutrient abundance, however, this layer becomes highly inactive and the quantity of roots penetrating it is sharply reduced, while the presence of decayed root residues can be observed in soil thin-section even after many years. Since organic matter resting for decades in the "accumulation zone of undecomposed organic residues" means a hardly exploitable nutritive reserve, deposition of a manure layer is here just as unreasonable as in the "biodegradation zone" where an undesirably rapid decay and liberation of plant nutrients takes place. The optimum depth of manure ploughed in should thus be looked for in the accumulation zone of humus colloids. In this zone the organic matter is first transformed into bacterial cell material, then into colloidal humic matter (soil "plasma"); latter ensures the continuous nutrient supply of plants in the most favourable way. This favourable transformation is of the highest quantity at the inversion layer, where decomposition of humus produced takes place primarily on the surface of roots and in the rhizosphaere. In other words, by determining the depth of the inversion layer, the optimum depth of ploughing in the manure is, at the same time, also determined. In practice, on a characteristic site of the sandy soil in question, at a vertical distance of 10 cm, 8—12 mm thick test layers are placed of the organic

matter to be used later regularly. When examining thin-sections produced with cast resin of the deposited organic matter layers after 4—5 years with a microscope, the depth at which the highest quantity amorphous humus has been produced at the expense of organic structures can be detected. In this inversion layer (between 30 and 40 cm according to investigations carried out at Őrszentmiklós) not more than several per cent of organic structures deposited originally are left over after 4—5 years under Hungarian climatic conditions. They usually are replaced by massive compact dark amorphous colloidal humic matter of possibly secondary stratification. The characteristic aspect of such layers is shown by Fig. 2. Although the precise evaluation of thin-sections is rendered possible primarily by the micromorphometric methods (see later in our detailed publication), the inversion layer can be determined for certain with simple microscopic examinations as well. Knowledge of the depth of inversion layers of sandy soil types occurring in the individual farms provides a firm ground for rational organic matter management.

Detailed micromorphological discussion of organic matter transformation taking place in sandy soils will be published in another place.

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REFERENCES

Egerszegi, S. (1958): Creation and permanent maintenance of a deep fertile layer in loose sandy soils. Acta Agronomica Acad. Sci. Hung., **7**, 333.

Klimes-Szmik, A. (1955): Nährstoffverhältnisse und landbauliche Beziehungen tiefgedüngter Sandböden. Agrokémia és Talajtan, **4**, 313.

Szabó, I.—Egerszegi, S. (1969): Micromorphological and microscopic biological investigation of a sandy soil improved by deep layering of organic matter. Third International Working-Meeting on Soil Micromorphology. Wroclaw. Summaries of papers, 6.

EFFECT OF IRRIGATION ON FLOWERING AND FRUIT SET OF RED PEPPER

Paprika keeps flowering until the plant perishes with cold (Obermayer—Mándy—Benedek 1955). With red pepper too, flowering is stopped by the autumn frost only, however, the rate of flowering and fruit set as well as the number of fruits per plant are different from those of the paprika (Berényi 1969). Mándy's surveying methods (1955, 1960) provided great help in setting up, analysing and evaluating our studies on the flowering and fruit set of red pepper.

The rate of flowering and fruit set as well as the number of flowers and fruits per plant have been studied in the red pepper variety E 15 under irrigated and non-irrigated conditions. Investigations were carried on over four years (1965—1968) in a medium hard Danubian alluvial soil at Kalocsa, with the following two treatments:

Treatment 1: non-irrigated control

Treatment 2: soil moisture kept by regular irrigation over 70 per cent of the water capacity

On each occasion by treatment 2 40 mm water was given with the sprinkling method used. Spacing was 60 × 30 cm with three plants per each. Flowering and fruit set were followed with attention in 30 plants per treatment. The number of flowers was determined every second day. Data of transplanting and irrigating were the following:

The efficiency of flowering and fruit set is decisively influenced by the amount of water supplied either naturally or through irrigation in June and July. The total amount of precipita-

Operation	1965	1966	1967	1968
Transplantation	20, 5.	10, 5.	15, 5.	13, 5.
Irrigation	17, 7.	15, 6.	26, 6.	21, 28, 6.
	22, 7.	15, 7.	6, 17, 7.	5, 12, 7.
	2, 8.	13, 8.	22, 31, 8.	1, 12, 8.
		22, 8.	8, 21, 8.	27, 8.

tion in these two months is 115.0 mm on the average of 50 years. Natural precipitation in June and July was 173.2 mm in 1965, 237.1 mm in 1966, 86.5 mm in 1967 and 109.1 mm in 1968. The monthly average of the daily mean temperature in these two months is 22.1 °C on the average of 50 years. In 1965 and 1966 this value was but 20.6 °C, while in 1967 and 1968 22.3 °C. The amount of natural precipitation is presented in Fig. 1.

The rate of flowering and fruit set showed the following trend in our investigations. Flowering began on 20—30 June (Fig. 1). The daily number of flowers was initially (15—20 days) low, but later (15—20 days) became higher and higher; while, after having reached a maximum, the rate of flowering slowed down, and flowers were day by day less on the plants (15—20 days). According to the data by 10 August the rate of flowering became quite slow, and from then up to the end of the growing season, flowers appeared only after several days on the plant.

In Fig. 1 peaks and ends of the curves of flowering and fruit set do not coincide. The daily amount of fruit set was already reduced when the rate of flowering still increased. Not every flower produced fruit. At the beginning of flowering fruits developed from 50—75 per cent of the flowers. At the time of mass flowering, however, the rate of fruit set was in inverse ratio to that of flowering. Fruit set was practically finished by 5—10 August. The rate of flowering and fruit set in the irrigated treatment was the same as in the non-irrigated treatment — or did not differ significantly.

There was difference between non-irrigated and irrigated treatments in the number of flowers developed and fruits set per plant (Fig. 2). Under non-irrigated conditions 22—32, while as a reaction to irrigation 25—40 flowers developed per plant. On the four years' average the number of fruits set per plant was 6.33 under non-irrigated and 7.58 under irrigated conditions. The amount of fruits set under non-irrigated and irrigated conditions in the individual years of the experiment is presented in Fig. 2. In 1965 and 1966 irrigation had no effect on fruit set; the differences were not significant. According to Fig. 2 differences in the number of fruits set were 2.40 in 1967 and 2.21 in 1968, in favour of irrigation. Percentage S.D. was 1.83 in 1967 and 2.02 in 1968, that is, the amount of fruits set was significantly higher in these two drier seasons in favour of irrigation.

Irrigation influenced not only the quantity but also the quality of fruits (BERÉNYI 1969). In the years of the experiment, with soil moisture kept over 70 per cent of the natural water capacity, the pigment content in the milling product decreased by 5.02—13.63 per cent. At the same time irrigation increased weight and size per fruit by 2.83—26.72 per cent. No

great differences were found in the dry matter content. Investigations described in this paper were aimed at clarifying the effect on flowering and fruit set of water conditions presented previously.

According to data shown by Fig. 2 irrigation is necessary and successful if it is carried out when the amount and distribution of precipitation is not sufficient, that is, the prevailing weather is dry.

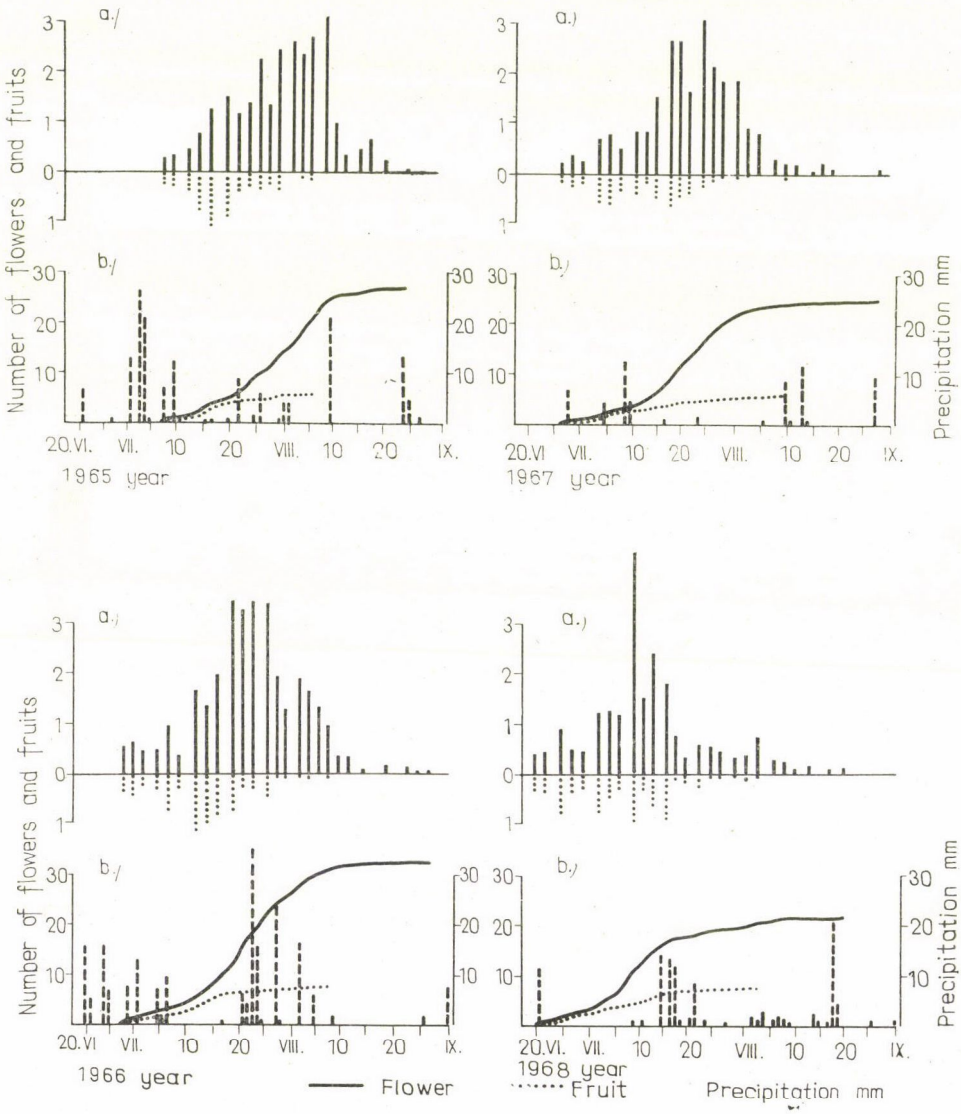

Fig. 1. Rate of flowering and fruit set of the non-irrigated control in the individual years, as related to one plant. a) Daily amount of flowers developed and fruits set. b) Course of flowering and fruit set, cumulative values. Amount of precipitation

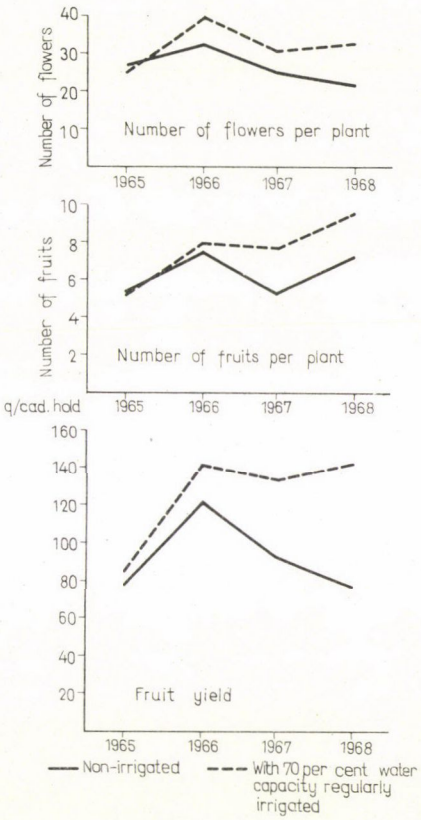

Fig. 2. Trends of flowering, fruit set and yield. (Kalocsa 1965—1968)

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Prepared at the Agricultural Research Institute of Danube-Tisza Mid Region, Department of Red Pepper Breeding and Production, Kalocsa

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REFERENCES

Berényi, M. (1969): A fűszerpaprika öntözésének egyes kérdései (Some questions of irrigating red pepper). Doctoral dissertation. Manuscript. Kalocsa, 1—138.

Mándy, Gy. (1955): Ökológiai felvételezési módszerek és újabb kutatási eredmények (Ecological surveying methods and recent research results). Időjárás, **59/2,** 71—79.

Mándy, Gy. (1960): Új ökológiai vizsgálati módszer és eddigi eredményei (New method of ecological surveying and results obtained so far). Kísérletügyi Közlemények, Növénytermesztés, **58,** 3—24.

Obermayer, E.—Mándy, Gy.—Benedek, L. (1955): A paprika (Paprika). Akadémiai Kiadó, Budapest, 64—66.

CYTOKININ ACTIVITY OF THE FRUITING BODY OF COPRINUS MICACEUS FR.

Interaction of the phytohormones: auxins, gibberellins, cytokinins and growth inhibiting compounds have a regulatory effect on mitosis frequency, cell and tissue differentiation and other developmental processes (LEOPOLD 1964).

It is well known that microscopic and macroscopic fungi have the common characteristic of producing a great bulk of living organism in a short time by rapid cell division and growth, if external conditions are optimum (LILLY—BARNETT 1951). The rapid growth is the result of an active nucleic acid and protein synthesis. As the biosynthesis of the nutritive, curative and toxic substances of higher fungi or mushrooms can be traced back to basic biochemical processes, amplification of this kind of knowledge with new data is justified.

Among the phytohormones of fungi little is known about the physiological and biological properties of cytokinins, though considerable cytokinin activity was demonstrated in the uredospores (BUSHNELL—ALLEN 1962, KIRÁLY—POZSÁR—EL HAMMADY 1966). Cytokinin content and activity of higher fungi are probably outstandingly high (POZSÁR 1968).

For the purpose of investigation one of the most frequent fungi of the *Basidiomycetes*, the very rapidly growing *Coprinus micaceus* Fr. was chosen. Extraction of cytokinin from

Table 1

Cytokinin activity as compared to the effect of synthetic 100 ppm benzyladenine solution, expressed in the growth inhibition of barley root tested on the 3rd day after the beginning of germination

	Length of barley root mm	Root growth inhibition %	Cytokinin activity ppm	Dry weight per fresh weight g/10 g	Cytokinin activity related to 10 g dry weight ppm
Control (distilled water)	32.0	—	—	—	—
Benzyladenine	18.0	44	100	—	—
Extraction of *Coprinus micaceus* fruiting body	27.5	28	64	1.0	640

Table 2

Cytokinin activity in leaves and root tips of leguminous plants as tested on the 3rd day by the growth inhibition of barley root

	Length of barley root mm	Root growth inhibition %	Cytokinin activity ppm	Dry weight per fresh weight g/10 g	Cytokinin activity related to 10 g dry weight ppm
Control (distilled water)	29.0	—	—	—	—
Benzyladenine	21.5	26	100	—	—
Young leaf of *Trifolium pratense*	28.0	3.4	13	1.8	72
Root tip of *Vicia faba*	28.6	2.0	8	1.5	53

the young developing fruiting body and biological testing of its effectivity were carried out according to VAN DER KERK—VAN EYK—WEBER (1964) and VAN ONCKELEN—VERBEEK—MASSART (1965). 10 g freshly collected fruiting body of *Coprinus micaceus* Fr. was homogenized in a buffer of 6.5 pH, then after ethyl alcoholic extraction, distillation and centrifuging auxin, gibberellin etc. components were separated from the acidified (to 2.9 pH) solution with ethylic ether. After adjusted to a pH-value of 7.8, the active agenel was shaken into the n-butyl-alcoholic phase. After the solution had been evaporated on filter paper, n-butyl-alcohol was removed by water added repeatedly, and on the filter paper containing the active agent, 50 barley grains (variety Lédeci Beta) were germinated per each of four replications. The biological effect of cytokinins was tested on the 3rd day by the inhibition of root growth (Table 1).

Data show that the developing fruiting body of *Coprinus micaceus* Fr. contains compounds of effective cytokinin nature. For the purpose of comparison cytokinin activity was determined parallelly in sound young leaves of *Trifolium pratense* L. and roots of *Vicia faba* L. seedlings (Table 2). Activity was related in each case to the effect of a 100 ppm benzyladenine solution. (Origin of benzyladenine: Research Institute for Plant Protection, Budapest.)

In leguminous plants examined the endogenous cytokinin activity (8—13 ppm) corresponded with an effectivity of about 10 ppm found in cereals as appropriate to benzyladenine (BUSHNELL—ALLEN 1962), that is, the endogenous cytokinin activity of *Coprinus micaceus* Fr. was 7—8 times higher as compared to them. The difference is even greater when activity is related to 10 g dry matter.

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Prepared by the National Institute of Agrobotany, Tápiószele

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REFERENCES

BUSHNELL, W. R.—ALLEN, P. J. (1962): Induction of desease symptoms in barley leaves produced by single colonies of powdery mildew. Plant Physiol., **37,** 50—59.

KIRÁLY, Z.—POZSÁR, B. I.—EL HAMMADY, M. (1966): Citokinin aktivitás rozsdafertőzött növényekben: a fertőzött levélszövetek juvenilitása és szeneszcenciája (Cytokinin activity in plants infected with rust: juvenility and senescence of infected leaf tissues). Bot. Közl., **53,** 217—223.

LEOPOLD, C. A. (1964): Plant growth and development. McGraw-Hill Book Co. New York—San Francisco—Toronto—London.

LILLY, V. G.—BARNETT, H. L. (1951): Physiology of the fungi. McGraw-Hill Book Co. New York—Toronto—London.

POZSÁR, B. I. (1968): Citokininek előfordulása nagygombákban (Occurrence of cytokinins in higher fungi). Mikológiai Közlemények, **2,** 84.

VAN DER KERK, G. J. M.—VAN DER EYK, G. M.—WEBER, J. A. (1964): Plant growth regulators and their interrelationships. Chemisch Weekblad., **60,** 185—194.

VAN ONCKELEN, H. A.—VERBEEK, R.—MASSART, L. (1965): Detection of a kinetin-like factor in barley with a new bioassay on kinetin-like activity. Nat. wiss., **52,** 46—47.

HABITUS STUDIES ON SEEDS OF VITIS VINIFERA L. SORTS

In the botanical and ampelographical literature the diagnostical role played by the seeds of *Vitis vinifera* L. sorts is generally neglected. It was ANDRASOVSZKY (1915) and POTEBNJA (1911) who made also sort diagnostical evaluations of most morphological characters of the seed in a small number of sorts. Our earlier investigations (FACSAR 1965, 1967) also indicated that the habitus of regularly developing seeds could be considered as a reliable charac-

teristic in sort diagnostics and used in taxonomic research. Present paper gives the results of examinations made on seeds of 250 sorts.

Since the habitus is — on the whole — a concept difficult to deal with, it was necessary to analyse its components. The habitus is composed of morphological factors: surface, size and colour. Among the morphological factors (silhouette, morphological variability of seed parts and their particulars, surface of the seed) it was the general outline that stress was laid on

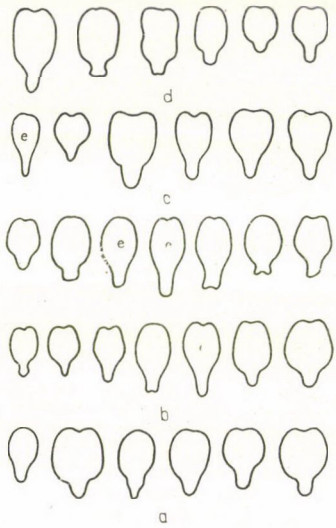

Fig. 1. Trends shown by the dorsal-ventral outline in sorts of *Vitis vinifera* L. a: seeds with round trunks, b: with pentagonal trunks, c: with triangular trunks, d: with quadrangular trunks, e: with long beaks

in the course of our investigations, as it is the factor decisively determining the habitus of the seed. The outline was examined from two main views, so that the zygomorphic seed could be characterized.

The dorsal-ventral silhouette shows the following trend in the basic types (Fig. 1): seeds with round trunks are widest in the medial line of the trunk, those with pentagonal trunks in the third part near the beak, while those with triangular trunks at the end opposite to the beak. Lateral lines of quadrangular seeds are approximately parallel, sometimes indented at the height of the chalaza. With long beaked seeds beaks longer than the average have dominant morphological influence. These are interpreted within the former types of trunk because of the supposed morphogenetical relations of sort development (FACSAR 1967, LEVADOUX 1956, NEGRULJ 1960).

Profile silhouettes can also be grouped by types. Spider-shaped seeds have straight ventral lines and characteristic shoulder humps. On straight seeds the axis of the beak coincides with that of the trunk. In the general type the axis of the beak and that of the trunk breaks at the shoulder. In crescent-shaped seeds the ventral side of the trunk is concave and the hump has not developed on the shoulder. Short beaked seeds of Vitis species are semicircular in case of berries with two-three seeds, while one-seeded berries have round seeds in the same species (Fig. 2).

The beak of the seed is an important character since changes in its size and proportion are related with the growth of the seed (FACSAR 1965). The beak of the seed should also be examined from the former two main views. The shape of the beak depends on the forms of

the tip and the base (transition from the beak to the trunk). The following types may occur accordingly: conical, columnar, clubbed and wedgeshaped.

The shape of the chalaza (round, oval, narrow oblong) on the dorsal side is varied even within a sort; its being either indented or level or protruding is often more characteristic of the sort.

Divergent, parallel or convergent nature of ventral striae is a specific and constant character. The contour of the ventral striae, on the other hand, is variable even within the sort.

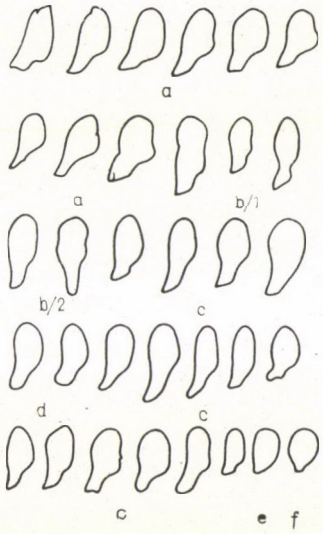

Fig. 2. Trends shown by the profile outline in sorts of *Vitis* sp. a: spider-shaped seeds, b: straight flat seeds (1) and clubbed seeds (2), c: general type, d: crescent-shaped, e: semicircular, f: round

Indistinct or distinct appearance of minor designs on the surface of seeds is considered to the characteristic of the sort.

The size of the seed influences the habitus, but the absolute measurements reflect ecological effects too. Absolute and relative changes in the measurements of the seed as a whole and its parts respectively are, at the same time, evolutionary characters, important in the archeological and genetical sort research.

The colour of seeds can be considered as characteristic of the sort if the seed was removed from the flesh of the berry when fresh. Then the evenness of the colour should be taken into consideration. The beak of the seed and the ventral striae are often, while the chalaza less frequently, of different colour. The colour of seeds is a less reliable and constant character than structural characters are.

Acknowledgement

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REFERENCES

ANDRASOVSZKY, J. (1915): A szőlőmagvak diagnosztikus értéke (Diagnostic value of grape seeds). Borászati Lapok. XLVII. Appendix to Nos. 38 and 39. Budapest.

FACSAR, G. (1965): Szőlőfajták magjainak összehasonlító morfológiai vizsgálata (Comparative morphological study on seeds of grape sorts). Tudományos Diákköri Füzetek. Agrártudomány, Budapest, 48—56.

FACSAR, G. (1967): Szőlőfajták rendszertani viszonyainak vizsgálata különös tekintettel a mag morfológiájára (Study on the taxonomic relations of grape sorts with special regard to the morphology of seed). A Kertészeti és Szőlészeti Főiskola Kiadványai. A Lippai János Tudományos Ülésszak előadásai. 1966. Szeptember 5—7. Budapest, 511—522.

LEVADOUX, L. (1956): Les populations sauvages et cultivées de *Vitis vinifera* L. INRA. Extrait des Annales de l'Amélioration des Plantes. Paris, **1,** 59—117.

NEGRULJ, A. M.—Негруль, А. М. (1960): Эволюция размера семян и ягод у винограда. (По данным изучения семян винограда из археологических раскопок СССР.) Известия ТСХА, **2,** (33). 167—176.

POTEBNJA, A. A.—Потебня, А. А. (1911): Семена европейских сортов винограда и их значение для классификации. Труды Бюро по прикладной ботанике. С. П. Б., **3,** 147—158.

EFFECT OF GROWTH REGULATORS ON THE DEVELOPMENT AND ALKALOID CONTENT OF POPPY CAPSULES

Knowledge of the action mechanism of growth regulators contains many unsolved problems. Studies on their effects exerted on the development of organs (root, shoot, leaf, flower) have recently begun to yield results (BLAYDES 1964, FORSYTH—SAMBUSSKY 1960, GARLSTON—BAKER—KING 1953, GRACZA—POZSÁR 1968, HUMPHRIES 1958, JUNG 1967, PETERBURGSKY—KULYUKIN 1967, WITTWER—DEDOLPH 1963).

Present paper deals with the effects exerted by growth regulators on the capsule organization and alkaloid content changes in poppy.

The experiments were carried out in 1968 on the poppy variety "SB morphine" developed at the Department. Ten growth regulators (stimulants and inhibitors) were used, namely: benzyladenine, kinetin, beta-indole-acetic acid, benzimidazole, gibberellin, chloro-coline-chloride, 2 CH fluorenol 9-carbon acid methyl ester, 6 methyl uracyl. The experiments were performed in the experimental field of the Biological Station of the Eötvös Loránd University at Alsógöd. One or two days after flowering, growth regulators of 30—100 mg/l concentration were injected into capsules just beginning to develop, in quantities of 1—2 cm^3, in some 30 replications. During the development of capsules the effect of treatment was already shown by the shape and measurements of capsules. The ripe dry capsules were examined for alkaloid content by means of thin-layer chromatography.

When presenting the results, morphological data are given first. Capsules of untreated plants showed a flattened shape, characteristic of the variety. Vertical and horizontal diameters of the capsules were nearly the same. As a reaction to treatments with benzyladenine and kinetin (both belonging to cytokinins) a capsule form, relatively elongated as compared to the control developed, which showed a somewhat larger vertical and smaller horizontal diameter. That is, these substances stimulated the longitudinal growth of the capsules. A definite growth inhibiting effect was found in the case of benzimidazole although no change occurred in the shape of the capsule, measurements fell considerably behind those of the control. Treatments with chloro-coline-chloride resulted in an even stronger inhibition. A slightly elongated capsule shape was obtained, but the capsules stopped growing early and remained very small. Treatment with beta-indole-acetic acid resulted in an effect very similar to that caused by benzyladenine and kinetin. Here too an oblong capsule shape was obtained with

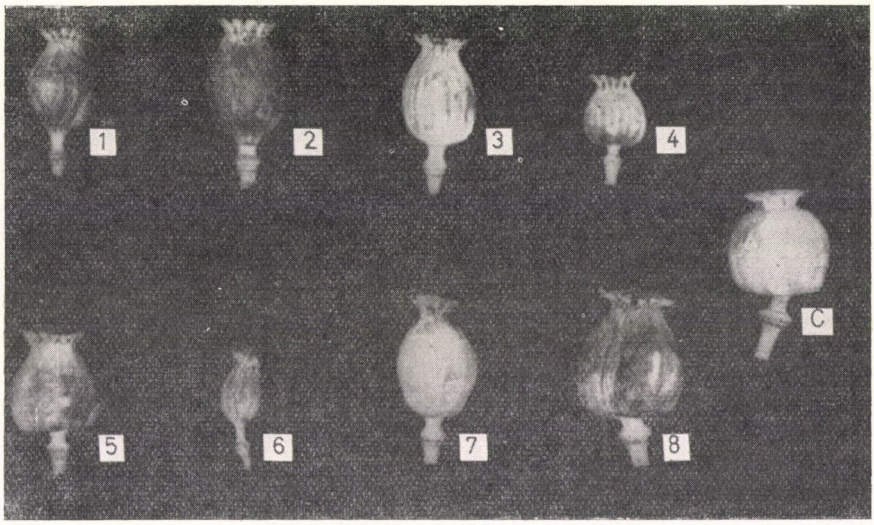

Fig. 1. Capsules treated with growth regulators: 1. benzyladenine, 2. kinetin, 3. beta-indole-acetic acid, 4. benzimidazole, 5. gibberellin, 6. chloro-coline-chloride, 7. 2 CH-fluorenol-9-carbon acid-methylester, 8. 6-methyl uracyl, C. control

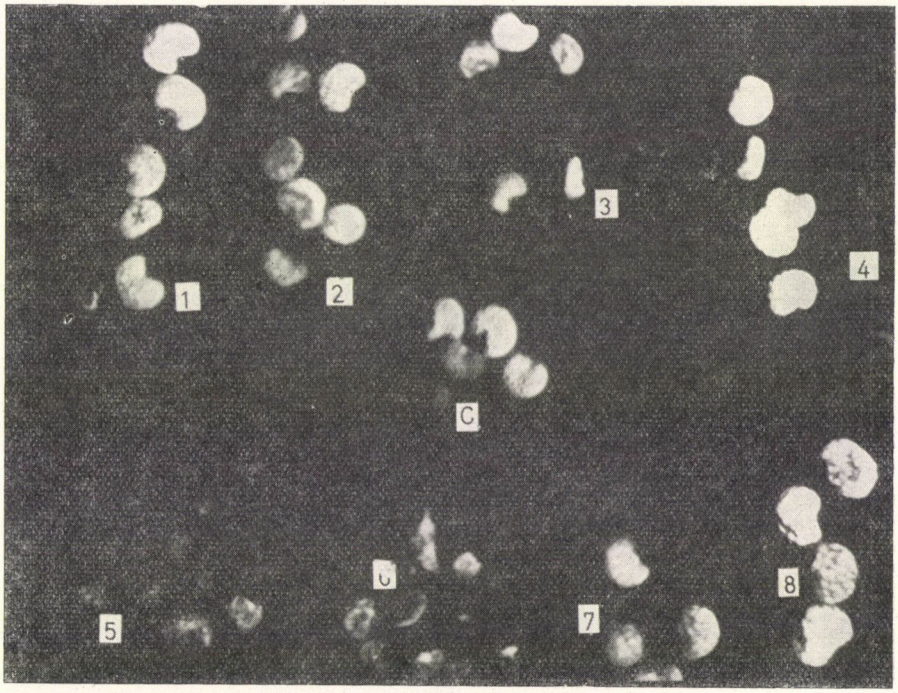

Fig. 2. Seeds originating from capsules treated with growth regulators: 1. benzyladenine, 2. kinetin, 3. beta-indole-acetic acid, 4. benzimidazole, 5. gibberellin, 6. chloro-coline-chloride, 7. 2 CH-fluorenol-9-carbon acid-methylester, 8. 6-methyl uracyl, C. control

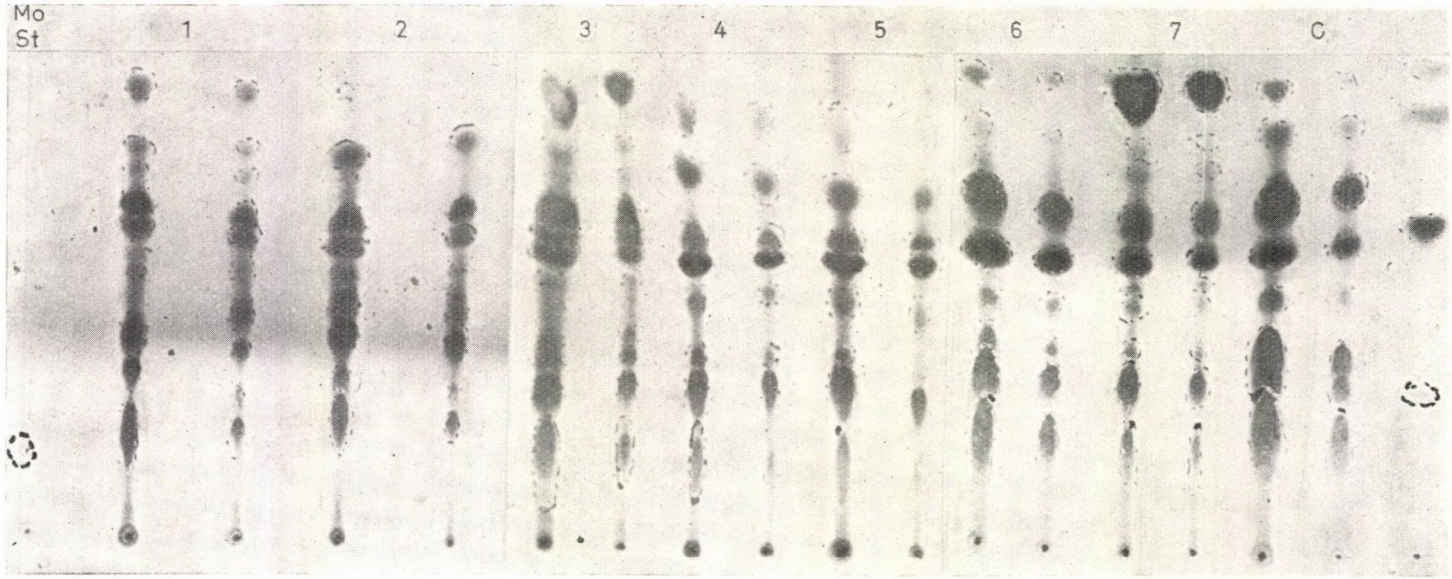

Fig. 3. Alkaloid contents of capsules treated with growth regulators as determined by thinlayer chromatography: 1. benzyladenine, 2. kinetin, 3. beta-indole-acetic acid, 4. benzimidazole, 5. gibberellin, 6. 2 CH-fluorenol-9-carbon acid-methylester, 7. 6-methyl uracyl, K. control

Table 1

Size and weight conditions of capsules treated with growth regulators

Treatment	Average length (mm)	Average width (mm)	Weight (g)
Benzyladenine	40	28	2.10
Kinetin	46	30	2.80
Beta-indole-acetic acid	43	29	3.00
Benzimidazole	32	22	1.60
Gibberellin	42	32	3.50
Chloro-coline-chloride	30	16	1.10
2 CH-fluorenol	45	32	3.80
6-methyl uracyl	45	37	4.10
Control	41	36	3.90

a diameter smaller than that of the control. In comparison with the above treatments a stimulating effect could be observed in the case of gibberellin, 2CH fluorenol 9 carbon acid methyl ester and 6 methyl uracyl.

Under the influence of 2CH fluorenol 9 carbon acid methyl ester the top and the basal part of the capsule narrowed, while the middle widened, so a barrel-like form developed. Gibberellin and 6 methyl uracyl treatments resulted in capsules widening at the base and narrowing at the top. Measurements of all three treatments are either similar to those of the control, or larger — as e.g. in the case of 6 methyl uracyl (Fig. 1).

A table is presented to show the measurements of capsules in the different treatments. Means were calculated on the basis of 30—35 measurings (Table 1).

There are also considerable differences in size between seeds developing in the capsules (Fig. 2). Treatments with benzyladenine, kinetin and beta-indole-acetic acid result in smaller,

Table 2

Alkaloid contents in poppy capsules treated with growth regulators

Mo: morphine; Co: codein; The: thebain; Pa: papaverin; Narc: narcotin

Treatment	Alkaloid content %					
	Mo	Co	The	Pa	Narc	Other
Benzyladenine	5.0	0.3	0.4	0.1	0.4	4
Kinetin	4.5	0.4	0.3	0.3	0.1	4
Beta-indole-acetic acid	7.0	0.5	0.5	0.2	0.6	7
Benzimidazole	4.0	0.4	0.4	0.3	0.3	4
Gibberellin	5.0	0.6	0.5	0.5	0.4	2
2 CH-fluorenol	7.5	0.5	0.6	0.1	0.3	3
6-methyl uracyl	4.0	0.3	0.5	0.1	0.7	4
Control	7.5	0.6	0.4	0.2	0.3	2

while gibberellin and 6 methyl uracyl treatments in somewhat larger seeds as compared to the control.

As regards the alkaloid content, major differences are found only in the quantity of morphine (Fig. 3). In general, lower values were obtained as a result of treatments. A 7.5 per mille value of the control was attained with 2 CH-fluorenol-9 carbon acid methyl ester, while beta-indole-acetic acid was near to it with a value of 7 per mille. Benzimidazole, benzyladenine, kinetin, gibberellin and 6-methyl uracyl attained an average of 4—5 per mille. As regards secondary alkaloids, differences are not so great, moreover, in certain cases — as e.g. with gibberellin treatment — the amounts of thebain, papaverin, narcotin are higher than in the control. Beta-indole-acetic acid and 6-methyl uracyl have the same effect on thebain and narcotin.

All these suggest that — except for beta-indole-acetic acid and 2 CH-fluorenol-9 carbon acid-methyl ester — substances used, especially cytokinins, influence the process of senescence by increasing the primary metabolism (retarding senescence) — and perhaps metabolite transport — thus suppressing the formation of secondary materials.

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REFERENCES

Blaydes, D. F. (1964): Biochemical and physiological studies of kinetin action. Diss. Abstr. Michigan, **24/9,** 3512—3513.

Forsyth, F. R.—Sambussky, D. J. (1960): Effects of kinetin and benzimidazole on the growth of etiolated pea stems and barley coleoptyles. Canad. J. Bot., **38,** 875—881.

Garlston, A. W.—Baker, R. S.—King, J. W. (1953): Benzimidazole and the geometry of cell growth. Physiol. Plant., **6,** 863—872.

Gracza, P.—Pozsár, B. (1968): Experimentelle Beeinflussung des Wurzelorganisationsvorganges der Bohne. Bot. Közlem., **55,** 278.

Humphries, E. C. (1958): Effect of gibberellic acid and kinetin on the growth of the primary leaf of dwarf bean *(Phaseolus vulgaris* L.). Nature, **181,** 1081—1082.

Jung, I. (1967): Syntetische Wachstumsregulatoren insbesondere Chlorcholinchlorid. Naturwissenschaften, **54,** 355—360.

Peterburgsky, A. V.—Kulyukin, A. N.—Петербургский, А. В.—Кулюкин, А. Н. (1967): Действие хлорколинхлорида на рост и развитие проростков пшеницы. Сел. хоз. Акад., **9,** 85—89.

Wittwer, S. H.—Dedolph, R. R. (1963): Some effect of kinetin on the growth and flowering of intact green plants. Amer. J. Bot., **50,** 330—336.

WINTER WHEAT KARCAGI 522

Taxonomic position: Triticum aestivum L. var. *erythrospermum* (KÖRN.) MSF.

Origin: Unknown South-American variety × Székács 1242.

Beginning of breeding: 1948, Karcag.

Breeder: Ernő Vezekényi and Béla Nagy, Karcag; the variety is maintained by the breeders.

State qualification: provisionally certified improved variety, 1959.

General characteristics: winter-hardy, tolerant to drought and even to alkali soils, fast developing, fit for extensive conditions, reliably and sufficiently yielding, red grained, bearded winter wheat with better than medium flour quality.

Morphological description:

Root system: penetrates into the soil to a depth of about 80—100 cm; some 73—75 per cent of the root system is found in the upper 10 cm of the cultivated soil layer, and only 13 per cent in the 20 cm layer below (KÁRPÁTI—MÁNDY 1961).

Shoot system: moderate tillering with quickly developing shoots.

Culm: of an average length of 109.8 cm (ranges from 88 to 129 cm), medium thick, moderately susceptible to lodging (ratio: 3.36; the best is 5); of straw-yellow colour when mature.

Foliage: leaves of young plants are linear lanceolate, light yellowish green, and have slightly hairy, purplish auricles. Leaf blades are broad, yellowish green. When maturing the purplish auricles gradually become white.

Ear: bearded, oblong prismatic, yellowish white when mature, rather loose, highly fertile, bending. Spike lets normally contain 2—3 grains which scarcely drop when ripe. Grain weight per ear is 0.67 g (ranging from 0.53 to 0.76 g), grain number per ear 19 (ranging between 14 and 22). Number of ears per m^2 439 (ranging from 421 to 459). Beard medium long, finely shaped. Glumes are narrow with simple shoulders and tips ending in short beards (PAPP 1960, PAPP—SZABÓ 1963, KAPÁS *et al.* 1965).

Caryopsis: elongated ovate, brownish red colour, its substance hard, flinty. Thousand-grain-weight 35.3 g on the average (ranging between 33.0 and 36.8 g). The quality of flour is good (B_1-A_2), wet aleuron content 10.6—11.4 per cent, dry aleuron content 28—30 per cent (PAPP 1960, PAPP—SZABÓ 1963).

Biological characters:

Germination: cardinal points: minimum +2 °C, optimum: 15 °C, maximum: 35 °C. Optimum germination period 3 days (MÁNDY 1951).

Vegetative period: from seeding to ripening 263 days on the average (ranging from 250 to 271 days).

Development: rapid, tillering intensive, earing, flowering, ripening early (that is why this variety is free from black stem rust).

Winter hardiness: unobjectionable, best among Hungarian varieties.

Resistance to diseases: not too much susceptible to smut and slightly susceptible to leaf-rust and powdery mildew (KAPÁS *et al.* 1965).

Farm technology requirement:

Seeding: medium early, at the end of September and beginning of October (MÁNDY 1967). Seed requirement: 3.0—3.2 million grains per cad. yoke* (520—540 grains per m^2) (KAPÁS *et al.* 1965).

Soil requirement: develops well even under extensive conditions, yields are especially good in soils inclined to alkalization or in alkali soils; utilizes medium quantities of fertilizers, lodges in case of too much nitrogen fertilizer (KAPÁS *et al.* 1965). Precipitation requirement rather low.

Productivity: average yield of many years 17.0 q/cad. yoke (ranging from 13.0—19.9 q/cad. yoke); straw yield average 33.3 q/cad. yoke (ranging between 22.2—42.7 q/cad. yoke) (PAPP 1960, PAPP—SZABÓ 1963).

Area of cultivation: in extensively cultivated soils of the Great Plain and Transdanubia in Hungary it can be economically grown instead of variety F. 481 (PAPP 1963).

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REFERENCES

KAPÁS, S. *et al.* (1965): Minősített növényfajtáink (Certified Hungarian plant species). Mezőgazdasági Kiadó, Budapest.

KÁRPÁTI, I.—MÁNDY, GY. (1961): Adatok nemesített búzafajtáink gyökérzetének mennyileges viszonyaihoz (Quantitative relations of roots of improved Hungarian wheats). Búzatermesztési kísérletek 1952—1959. Akadémiai Kiadó, Budapest, 532—547.

MÁNDY, GY. (1961): A csírázáshőmérséklet kardinális pontjainak vizsgálata hazai őszibúza fajtákkal (Study on the cardinal points of germination temperature in Hungarian winter wheats). Búzatermesztési Kísérletek 1952—1959. Akadémiai Kiadó, Budapest, 105—109.

MÁNDY, GY. (1967): Őszi búzák fenoökológiai vizsgálata (Phenoecological examination of winter wheats). Agrobotanika, 1965-2, **7/2,** 29—41.

PAPP, ZS. (1960): Őszi búza (Winter wheat). Nemesített Növényfajtákkal Végzett Országos Fajtakísérletek Eredményei 1959. Mezőgazdasági Kiadó, Budapest, 111—135.

PAPP, ZS. (1963): Hazai búzafajták (Hungarian wheat varieties). In: LELLEY—MÁNDY: A búza (Wheat). Magyarország Kultúrflórája. Akadémiai Kiadó, Budapest, **8/13,** 277.

PAPP, ZS.—SZABÓ, M. (1963): Őszi búza (Winter wheat). Nemesített Növényfajtákkal Végzett Országos Fajtakísérletek Eredményei 1962. Mezőgazdasági Kiadó, Budapest, 119—148.

* 1 cad. yoke = 5754.56 m^2 = 1422 acre

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FORUM

NEW CONCEPT OF THE ORIGIN OF TRITICUM AESTIVUM L.*

SEARS (1959) describes three modes of origin for two subspecies of *Triticum aestivum* L. [ssp. *spelta* (L.) THELL., by others *Triticum spelta* L., and ssp. *vulgare* (VILL., HOST.) MAC KEY, by others only *Triticum aestivum* L.], assuming that the three tetraploid wheat species taking part in the origin of the two subspecies have, from the beginning, been in connection with the species *Aegilops squarrosa* L. He writes the following: "Assuming that the distributional areas of *T. dicoccum*, *T. dicoccoides* and *T. carthlicum* all overlapped that of *Ae. squarrosa* in ancient times as they do now, three different modes of origin are possible for both *spelta* and *vulgare*. *Spelta* may have arisen 1. as an amphiploid of *dicoccum* (or *dicoccoides)* × *Ae. squarrosa*, 2. as a segregate from *vulgare* (or *compactum)* × *dicoccum*, or 3. as a mutant from *vulgare*. *Vulgare* may have arisen 1. as an amphiploid of *carthlicum* × *Ae. squarrosa*, 2. as a segregate from *spelta* × *carthlicum*, or 3. as a mutant from *spelta*. Thus the exact method of origin of either *spelta* or *vulgare* may be very difficult to determine, even though archeological evidence may eventually establish which arose first."

Archeological research work carried out in the last decade and published by RUDORF (1968) in a detailed report certainly helped to overcome the difficulties and settle the problem raised by Sears. Excavations performed in the area of the "fecund crescent" disclosed grain remnants of *T. monococcum*, *T. dicoccum* and *T. aestivum* (ssp. *vulgare!)* only, while *spelta* was not found anywhere. *Spelta* only became known as originating from the Bronze Age in Europe, though it had not originated here — as believed earlier — but in an area overlapping that of *Aegilops squarrosa*. This place was determined with a high probability by MCFADDEN—SEARS (1946), "suggesting that it had originated in the Caucasus region and had been transported via a northern route to western Europe" (SEARS 1959). Thus, the northern part of the Caucasus where *Ae. squarrosa* still reaches is probably the place of origin for *spelta*. It is a question which wheat species was the progenitor of *spelta*. It probably could not be *T. dicoccum* or *vulgare* itself. Some tetraploid Caucasian wheat species, perhaps *T. carthlicum* or *T. turanicum*, but even one of the northern-Caucasian forms of *T. georgicum* can be supposed to have been the progenitor of wheat. Further investigations are required to decide on this question.

According to investigations made so far it is probable that there was a difference of some 2—3 thousand years in the time of origin between ssp. *vulgare* and ssp. *spelta*, that is, *spelta* may have originated 2—3 thousand years later than *vulgare*. The two subspecies are, however, separated from each other not only by time, but also by the high mountains of the Caucasus. Thus, they could not possibly either originate from each other or take part in each other's origin. The fact that the origin of the hexaploid wheat species took place in more than one ways — i.e. it is not "monophyletic", as generally stated in the literature — should thus be taken into account.

From among theories concerning the origin of the subspecies *vulgare* those presenting the ssp. *spelta* as progenitor should be put aside. Thus, among the three theories mentioned

* This study was copied word for word from the author's original (Editorial Board).

above only the first is probable, namely, that *vulgare* was produced by the crossing and subsequent amphiploidization of *T. carthlicum* × *Ae. squarrosa*. This theory is, to-day, generally agreed upon, but it is the mode of origin of *T. carthlicum* that has not been clarified as yet.

In his monograph FLAKSBERGER (1935) wrote about *T. carthlicum* as being an alpine "ecotype" developed from *T. aestivum* × *T. durum* intercrossed. This theory cannot be accepted as *T. aestivum* ssp. *vulgare* is a progeny of *T. carthlicum*, and it cannot produce its progenitor. Anyway, *T. carthlicum* developed in the Caucasus region, while *T. durum* in South-Africa not earlier than in the Bronze Age, that is, much later and very far away (ORLOV 1923).

The wheat-progenitor of *T. carthlicum* must, undoubtedly, be looked for in its present area. It is obviously *T. georgicum* Dekapr. (= *T. palaeocolchicum* Men.), a similar tetraploid species of more primitive character, from which *T. carthlicum* developed by mutation (grains drop from spicelets). It seems highly probable that *T. georgicum* was the progenitor for *carthlicum;* and *T. turanicum* Jakubz. also perhaps, developed as a parallel mutation in the eastern part of its area and spread east of the Caspian Sea, in northern Iran. *T. turanicum*, having fallen within the area of *Aegilops squarrosa*, became the progenitor of the Central-Asian wheat species (such as the short round-grained *T. sphaerococcum* Perc. and *T. amplissifolium* Zhuk. grown in China) on one hand, and took part in developing the Iranian *speltas* on the other, through spontaneous crossing with *Ae. squarrosa* and amphiploid mutation.

What is the probability of *T. carthlicum* developing from *T. georgicum* by mutation and not from *T. dicoccum* as generally expressed in the literature? First of all, hexaploid wheat species could develop only in the area of *Aegilops squarrosa*. According to ZOHÁRY *et al.* (1969) the westernmost part of this area is Trans-Caucasia. Sporadically, it was found further in Kurdistan and Syria, but only in the eastern regions. Thus *Ae. squarrosa* could hardly meet, in the neolithic age, *T. dicoccum* that developed in Asia Minor; so the necessary crossing could not take place. *T. dicoccum* migrated westward and southward rather than towards the hard eastern regions (where wheat had already been established). Thus in 6000—7000 B.C. *T. dicoccum* could not get from Asia Minor to Trans-Caucasia (in a direction just opposite to that of the "neolithic wave", and to the known growth of plant kingdom), it was soon replaced by the local tetraploid relative, *T. georgicum*. Thus *T. dicoccum*, disclosed in Jarmo (RUDORF 1968), could not be other than *T. georgicum* (since they are very much alike, especially in the shape of the grain observed). It should be, therefore, thoroughly examined, whether the find of Jarmo could still be identified as *T. georgicum*.

In 2000—3000 B.C., (or even later) in Egypt, Abyssinia and North-Africa, *T. dicoccum*, transported southward, developed into *T. durum*, *T. turgidum* and *T. polonicum* through mutations. These tetraploid wheat species of late origin gained ground in the warmer regions, and in the historical times spread to the east as well. Nevertheless, their main area is the Mediterranean region, and, endemically, Abyssinia too. Wheat evolution characterized with *T. dicoccum* could not thus get further than the tetraploid level: natural conditions (warmer climate, level lands) and the absence of *Ae. squarrosa* hindered any further development.

Before summarizing the probable course of evolution, the possible origin of *T. georgicum* should be examined. *T. monococcum* could hardly be the diploid wheat-progenitor of *T. georgicum*, since former spreaded westward (SCHIEMANN 1932). Though VAVILOV (1926) suggested two centres of origin: 1. Trans-Caucasia and 2. Palestine, recently only Asia Minor (southern part of Anatolia) is considered to be the gene centre. Nevertheless, Vavilov pointed out the possibility of two separate origins of diploid wheats, and in this respect came near the truth. *T. monococcum* could, however, be diploid wheat-progenitor only for the western gene centre, the eastern gene centre had another related species, *T. urartu* Tum. as diploid progenitor. It is not known whether *T. urartu* developed from *T. boeoticum* by parallel mutation (similarly as *monococcum* did), or some other wild form had been its progenitor. However, it is a fact that this species exists endemically even to-day, and thousands of years ago might have had the

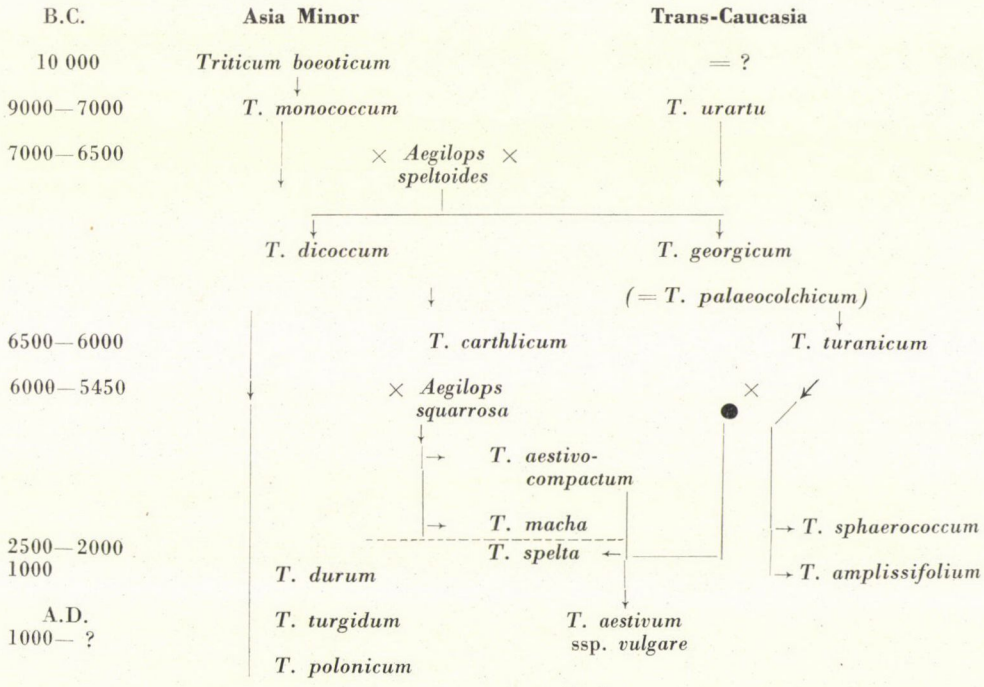
opportunity to cross with *Ae. speltoides*, and to produce *T. georgicum* through amphiploidization. The area of *Ae. speltoides* is near to that of *T. urartu* even to-day, and the situation was supposedly the same in ancient times too. Excavations at Jarmo disclosed both diploid (probably *T. urartu* but according to the literature *T. monococcum)*, and tetraploid (probably *T. georgicum* but according to the literature *T. dicoccum)* cultivated wheat in layers of 6750—9000 years B.C. (RUDORF 1968).

On the basis of what have been told above the origin of wheat species can be imagined in a chronological order as shown by the sketch presented here. When constructing the taxonomy of species this order of origin must, by all means, be taken as a basis; so arrangements where species of earlier origin are included in the morphological sphere of later ones reverse the real course of evolution. So, for example, *T. dicoccum* which originated some ten thousand years earlier, or the almost similarly old *T. georgicum (= T. palaeocolchicum)* cannot be ranged with the close relatives of the recently developed species *T. turgidum* (MAC KEY 1966). Anyway, in addition to the enormous distance in time, there is a great distance in the place of origin too between *T. georgicum* and *T. turgidum*, so that any evolutionary relation between them is highly improbable.

To sum it up, at least two major evolutionary courses can be established in the origin of currently grown wheat species; one of them has arrived at the hexaploid level while the other has remained tetraploid.

The two main lines of evolution are the following:

Sketch of the origin of wheat species, partly on the basis of the literature, partly by author's concept



1. *T. urartu* — *T. georgicum* — *T. carthlicum* — *T. aestivocompactum* — *T. aestivum*;
2. *T. monococcum* — *T. dicoccum* — (*T. durum* + *T. turgidum* + *T. polonicum*).

The main lines of evolution produced also side-lines of more or less importance, none of them attaining, however, as high a significance in world economy as the main line — especially line 1 — did.

When determining the natural course of origin of wheat species, both chronological order and geographical distribution should be taken into consideration besides other important aspects. It is obvious that a thousands of years earlier origin and distant or isolated geographical occurrence may define the taxonomic relation (if confirmed by other data as well). On this basis the evolutionary system of wheat species can be established as follows:

MONOCOCCA Flaksb. (2n = 14)
- *Triticum boeoticum* Boiss.
  - convar. *aegilopoides* (Link) My
  - convar. *thaoudar* Reut.
  - convar. *monococcum* (L.) My
- *Triticum urartu* Tum.

DICOCCOIDEA Flaksb. (2n = 28)
- *Triticum dicoccoides* Körn.
- *Triticum dicoccum* Schrk.
  - convar. *abyssinicum* Flaksb.
  - convar. *euroum* Flaksb.
  - convar. *europaeum* Flaksb.
  - convar. *maroccanum* Flaksb.
  - convar. *durum* (Desf.) My
  - convar. *turgidum* (L.) My
  - convar. *polonicum* (L.) My
- *Triticum georgicum* Dekapr.
  - convar. *palaeocolchicum* (Men.) My
  - convar. *carthlicum* (Nevski) My
  - convar. *turanicum* (Jakubz.) My
- *Triticum timopheevi* Zhuk.
  - convar. *araraticum* (Jakubz.) My
  - convar. *timopheevi*

SPELTOIDEA Flaksb. (2n = 42)
- *Triticum zhukovskyi* Men. et Er.
- *Triticum aestivum* L.
  - convar. *vulgare* (Vill.) My
  - convar. *macha* (Dek. et Men.) My
  - convar. *vavilovi* (Tum.) Sears
- *Triticum sphaerococcum* Perc.
  - convar. *sphaerococcum*
  - convar. *amplissifolium* Zhuk.
- *Triticum spelta* L.
  - convar. *alemannum* Flaksb.
  - convar. *ibericum* Flaksb.
  - convar. *iranicum* My

Triticum compactum Host. [or ssp. *compactum* (Host.) MK] set up by some authors as a species, and as a subspecies by others, has not been ranged with the species of the SPELTOIDEA series, because compact types should better be included in the morphological sphere of convar. *vulgare*, viz. in the *Triticum aestivum* species (under the general name of cv. *aestivo-*

compactoides). The name *T. aestivocompactum* merely indicates that the origin of the common wheat had begun with the ancient compact form, and it was only later that the characteristic "*vulgare*" type developed.

On the basis of what have been discussed above the area stretching in the mountain Zagros south of the Caucasus including the highlands of Georgia, Armenia, East-Kurdistan and Azerbaidzhan can be considered as the gene centre of *Triticum aestivum*.

*

Prepared by the National Institute of Agrobotany, Tápiószele

GY. MÁNDY

REFERENCES

FLAKSBERGER, K. (1935): Wheat. A monograph. Szel'hozgiz. Leningrad.
MAC KEY, J. (1966): Species relationship in *Triticum*. Hereditas, Suppl., **2,** 237—276.
MCFADDEN, E. S.—SEARS, E. R. (1946): The origin of *Triticum spelta* and its freethreshing hexaploid relatives. J. Hered., **37,** 81—116.
ORLOV, A. (1923): — Bull. Appl. Bot., **13,** 369—459.
RUDORF, W. (1968): Beiträge archäologischer Untersuchungen zur Frage der primären Entstehungsgebiete sowie der Genzentren der alten europäischen Kulturpflanzen, besonders des Weizens und der Gerste. Ztschr. Pflanzenzüchtung, **60,** 349—389.
SCHIEMANN, E. (1932): Entstehung der Kulturpflanzen. Borntraeger. Berlin.
SEARS, E. R. (1959): The systematics, cytology and genetics of wheat. In Kappert—Rudorf: Handb. d. Pflanzenzüchtung. 2. Aufl. Parey. Berlin—Hamburg.
VAVILOV, N. I. (1926): Studies on the origin of cultivated plants. Inst. Bot. Appl. Amél. Pl. Leningrad.
ZOHARY, D.—HARLAN, J. R.—VARDI, A. (1969): The wild diploid progenitors of wheat and their breeding value. Euphytica. **18,** 58—65.

IS THE EVOLUTIONARY IMPORTANCE OF GAMIA GREATER THAN THAT OF REDUCTION?

J. Stieber's paper: "Preliminary studies to the evolutionary interpretation of periodical ontogeny (alternation of generations) in plants" contains interesting and valuable new ideas and views. However, author expresses his thoughts too briefly and succinctly to make it possible to take a stand on them without a more detailed and more thorough documentation. Stress laid upon the evolutionary importance of gamy as opposed to reduction requires — in my opinion — further discussions. We are looking forward to a full exposition of author's ideas. — Minor remarks: Author gives conspicuously few literary references, especially handbooks; Anglo-Saxon sources are completely neglected. His phylogenetic standpoints were already included in the first publication of Soó's Fejlődéstörténeti növényrendszertan (Phylogenetical taxonomy) (1953), and attention should be called to latter's paper: "Hauptzüge der Evolution der Embryophyten" (Feddes Repertorium 76: 63—81, 1967; in Russian language: Botanichesky Zhurnal 1968) as well.

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PLANT ORGANS FROM ENDOSPERM?

The author has underlined the importance of nuclear phase change in the alternation of generations and in phylogeny as well.

The novel idea of representing the various ontogenetic stages by placing the axis of the spiral in the plane of the paper is interesting. But several questions would arise:

1. Whether the starting point is the haploid or diploid phase? Just the extrapolation of the horizontal line to the left will not answer the question (see Fig. 1).

2. Should sex be given such an important place at least in the earlier forms? Sexual reproduction is infrequent in the majority of the major divisions of algae. In 2 of the algal divisions the somatic phase is haploid *(Chlorophyta)* or diploid *(Bacillariophyta)*.

3. In earlier forms an alternation of generations is not obligatory.

4. What about apomiatic forms?

As claimed by the author it would not be easy to represent monoecy and dioecy.

The secondary reversion from sexuality in some asexual forms cannot be ruled out.

Genetic recombination may have a relatively low selective advantage and it may have disappeared in favour of rapid asexual multiplication in case of relatively stable environment.

The author's contention that there is no need for a chromosome set of even numbers is too drastic. In fact, reduction and sex act are complementary for the general premise of alternation of generations.

At least in many angiosperms in the development of endosperm not three but many nuclei are involved. It is very strange that the newly acquired third ontogenetic phase or generation should have a shorter life and is consummated by the diploid phase. Though the contention of the author regards endosperm as the third phase, not much evidence has been adduced. The work from this (Department of Botany, University of Delhi) laboratory, using tissue and organ culture techniques has demonstrated that endosperm can differentiate into root and shoot structures.

How does one explain the behaviour of the cells of the female gametophyte in members of *Gymnospermae* like *Gnetum* where nuclear fusions have been noted?

Fig. 2 — Requires certain changes. It does not properly explain the origin of 3N.

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CENTRAL CELL OR CENTRAL NUCLEUS?

J. Stieber's paper was published in the issue No. 1—2, 1970 of the Acta Agronomica. According to the communication from the Editorial Office, by an agreement arrived at with the author, comments may be made by both Hungarian and foreign experts on the paper, since, the author, obviously, intended it to be a topic for discussion. I too was called on and wished to take part in the discussion. I entreat the author's indulgence in advance in case my unprejudiced opinion does not agree with that of his in every point, but I make my comments for the cause of science.

Owing to lack of space I am obliged to make my remarks short, although the subject would be worth discussing at some length, the more so, as I myself wrote on the very subject 52 years ago, and recently in 1964 in much more details of which I enclose here 3 figures as a comparison to Stieber's similar two figures.

In general, I consider neither the form nor the content of the paper as perfect; it is not properly divided into parts, putting of the question and setting of the objective are omitted, the 7 pages paper are divided merely into 5 sections, so it is not easy to survey it; and finally, even the two summarizing sentences do not disclose why, in fact, the paper has been written. In the discussion the author does not call attention to essential facts, e.g. does not emphasize the interrelation between heteromorphic dioecious plants and the importance of intergrades; he does not mention any isomorphic specimen of either sea or terrestrial plants; even the two figures are not in complete accordance with the text.

I think it proper to make my comments as the text proceeds.

I do not even agree with the very first sentence. According to the author "it is known that ontogenesis in the *majority* of plants existing to-day consists *mostly* of two phases which follow one another by a change of chromosome phase". Why does the author speak of the

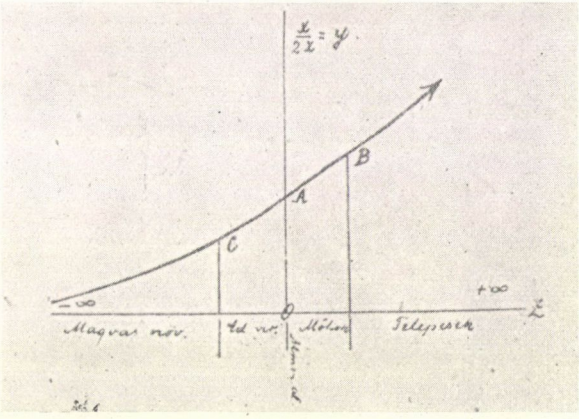

Fig. 1. Illustration of successiveness in generation alternation (delivered by the author at a meeting held on 9th January 1918 at the Botanical Section, Budapest). Magvas növények = Seedy plants; Edényes virágtalanok = Vascular cryptogams; Átmeneti alakok = Intermediary forms; Mohák = Mosses; Telepesek = Thallophytes

majority of plants as having an ontogenesis like that, and say it consists *mostly* of two phases? In my opinion, every known living organism has a sex — so alternation of generations too —, even the "anucleate" *Acariobionta* bacteria, have recently been found in F+, F± and F— phases meaning, in fact, different changes of phase. The same phases are found in all unicellular and multicellular organisms, and in these processes — as it has recently been pointed out — DNA plays the most important part. It is for this reason too, that in Andreanszky's book "Ősnövénytan" (Palaeobotany) the statement that alternation of generations appeared in the plants only in the Upper Silurian (although he speaks of sexual reproduction in the previous age) is wrong (see: Ősnövénytan, Table 1).

I perfectly agree with author on the statement that "evolution consists of endless series of periodical alternations of ontogenetic phases which" — he says — "is generally illustrated with a line recurring to itself, usually a circle". The author does not think this mode of illustration proper; in his opinion evolution is much better represented by a spiral, the projection of which is a sinus curve, and he wishes to demonstrate this thesis by a figure. In my opinion, however, this sinus curve does not express the essence of evolution. The curve in Fig. 1 shows the ontogenesis of an "intermediary isomorphic plant" (it is a pity that not one species is mentioned), but — I think — it proves just the consistency of species, since the first sector perfectly corresponds to the second, there is no difference between them:

accordingly, successive generations should be entirely similar to each other. Nevertheless, the author considers this mode of representation to be suitable to express all kinds and characteristic forms of ontogenetic periodicity. In my opinion, this sinus curve cannot be applied — among others — either to the homo- and heterothallia of *Thallophytes* or to the heteromorphic seed plants, where morphological differences are found between sexual and asexual generations (e.g. presence of dwarf males, gametophytons and sporophytons of heteromorphic mosses, heteromorphic prothallia of heterospored *Lycopsida*, ferns, horsetails, etc.). Anyway, I do not think that the letters G and R are properly placed in the figure, since — as they are — they show as if sexual process (G) and reduction (R) took place in the 2n generation only and nothing happened in the n generation. Letters G and R ought to be placed perhaps onto the line. I think — and it is up to the reader to decide — that all these developmental processes are

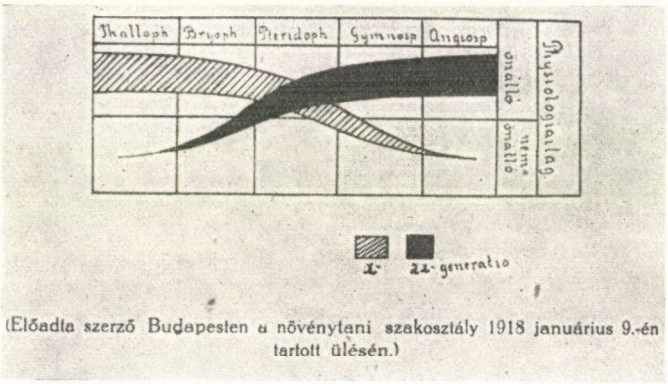

Fig. 2. Gradual development of chromosome phase changes (delivered by the author at a meeting held on 9th January 1918 at the Botanical Section, Budapest). Fiziológiailag önálló = Physiologically independent; Fiziológiailag nem önálló = Physiologically not independent; Thallophyta = Thallophytes; Bryophyta = Bryophytes; Pteridophyta = Pteridophytes; Gymnospermae = Gymnospermae; Angiospermae = Angiospermae; X generáció = X generation; 2 x generáció = 2 x generation

much better demonstrated by the two figures (Fig. 1 and 2) of my paper published in 1918, the first of which illustrate the degree of generation alternation with a mathematical curve but shows at the same time the necessary existence of intergrades as well (x : 2x = 1 : 1). I emphasized all these already when the intermediary isomorphic forms: the *Psilophytes* (Merker) and homomorphic generation alternations of *Cladophora*, *Drapalnaldiopsis* were not even known. And I believe that Fig. 2 too illustrates well the gradual development of chromosome phase changes, which also clearly shows that in *Pteridophyta* both the sporophyton and the gametophyton are physiologically independent and can be considered as intermediary forms of *Pteridophyta*. The author does not even mention *Pteridophyta* in the text although in this respect they are highly important intermediary types. The two figures prove, furthermore, that the question of alternation of generation was already dealt with more than 50 years ago, and attempts were made to illustrate the phenomena by diagrams as well.

The author traces back the chromosome phase changes generally to the influence of external factors, such as: unfavourable changes in life conditions, depletion of nutrients, decreased temperature, etc. I cannot quite agree with this opinion, since alternation of generations is a strict natural law with no exception which necessarily occurs even when plants grow under optimum conditions. No doubt, external factors may contribute to a shifting in chromosome phase changes, but it is not the most important cause.

Anyway, when in case of nutrient depletion, temperature decrease or desiccation —

that is, when life conditions become unfavourable — some *Acariobionta* change over to a *state of persistence*, it is not yet a sexual process, nor is it a periodical ontogenesis with a change of chromosome phase, it is only a simple vegetative transformation. The same goes for unicellular nucleate algae.

The author treats subsequently the subject of chromosome phase change in the individual categories. The idea of gradual development is not, however, elucidated in his discussion, the more so, because some material errors or lapsus calami slipped in too. For example, he says that the *Bacillariophytes* have oogamy, although they have not; the sporophyton of *Musci frondosi* is autotrophic, although it lives on the gametophyton. *Hepaticae* and *Musci frondosi* are not taxonomic categories equivalent to *Pteridophytes*, *Gymnosperms* and *Angiosperms*' since both belong to the class *Bryophytes*. "*Zygote*" and "*persisting cell*" are not identical

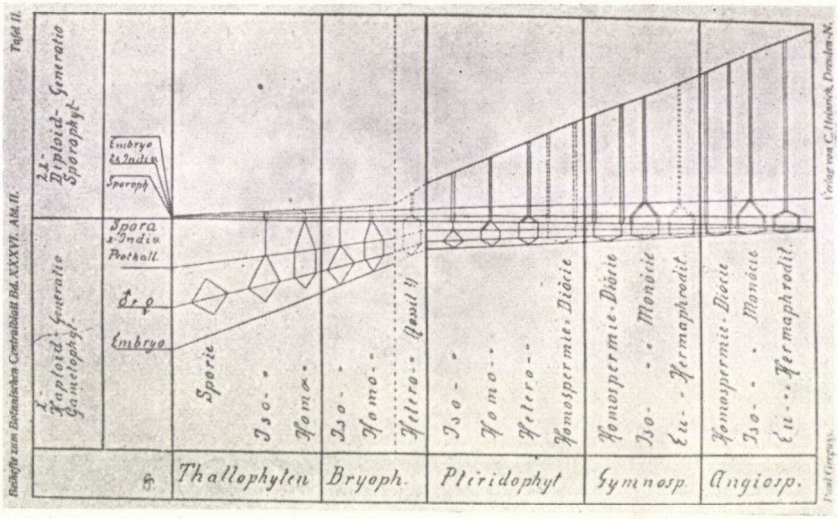

Fig. 3. Alternation of generations and its development in land plants (published in Vol. XXXVI. of Beihefte zum Botanischen Centralblatt 1918). X generáció = X generation; Haploid generáció = Haploid generation; Gametophyta generáció = Gametophyte generation; 2 x generáció = 2 x generation; Diploid generáció = Diploid generation; Sporophyta generáció = Sporophyte generation; Embrió = Embryo; 2 x egyedek = 2 x individuals; Sporophyta = Sporophytes; Spóra = Spore; X egyedek = X individuals; Prothallium = Prothallium; Isospóra = Isospore; Homospóra = Homospore; Heteróspóra (fosszilis?) = Heterospore (fossil?); Homospermia = Diöcia = Homospermy = Dioecy; Isospermia = Monöcia = Isospermy = Monoecy; Euspermia = Hermaphrodita = Euspermy = Hermaphrodity

morphological conceptions. The zygote is always the result of a sexual process (e.g. fertilization of ovule), while the persisting cell originates from the transformation of some vegetative cell, e.g. the cell filament of *Ulotrix* breaks up and the walls of the individual cells thicken. Neither does the gametophyton of *Fucus* consist of several cells "considered by some authors as gametes", only the unicellular spermatozoid and the ovule of the oogonium are the reduced gametophytes. Anyway, the gamete can never be "several cells".

When speaking of *Cormophytes* the author says that "the diploid form is initially less developed, lives on the autotrophic haploid form producing it, and then gradually becomes autotrophic, e.g. *Musci frondosi*." Here again the author is wrong, because at that stage it is not yet autotrophic; and finally he supresses the haploid form which becomes heterotrophic, parasitic, e.g. *Gymnospermae*. It is a pity that the author omitted *Pteridophytes* where both

forms are physiologically independent. He encloses a sketch to illustrate it, but only refers to it in the last sentence of the paper. I cannot see alternations of generation in unicellular organisms precisely shown by Table 2. *(Monadophytes* would have been a better name instead of *Euglenophytes.)* It does not emphasize the important intermediary forms e.g. between *Bryophytes* and *Pteridophytes*, does not refer — at least with a few words — to the fact that in the course of time sea algae underwent transformations essentially similar to those that land plants did, that is, independently of each other (in Fig. 2 the Ph line ought to be drawn to the end of *Angiospermae).* Perhaps Zimmermann's biologically inadequate theory according to which mosses originated by reduction from *Psilophytes*, while the latter from the sea algae might have occurred to him. In my opinion, alternation of generation land plants and its development are much better presented by my Table published in 1918 (Fig. 3). (This too I leave for the reader to decide.) In this Table and also in my paper mentioned above I called attention, 50 years ago, to the necessary existence of such intermediary forms, as were proved to exist later when various forms, or at least 3 main types of *Psilophytales* were found.

According to the author's words "with the dominance of diplonta the function of persisting cell shifted over to the spore, and in seedy plants to the multicellular seed". It is a pity that the author does not mention the spore types (isospores, homospores, anisospores, heterospores) of either the mosses or the vascular cryptogams, and the various seeds of heteromorphic seed plants the cells of which differ also in chromosome number and thus play an important role in the alternation of generations too.

Finally, the author deals with the double fertilization of *Angiospermae* and the evolution of the endospermium. Unfortunately, I have to call attention to some errors and lapsus calami in this respect too. In the author's opinion "there are 3 rather than 2 *sexual* processes here". He is wrong in speaking of 3 processes because, in fact, there are only 2. He is also wrong in saying that the embryo sac has a *central cell* resulting from the complete karyogamy of two small *cells*. The embryo sac has no *central cell*, only a *nucleus* (there is a great difference between the two) and the latter is the result of karyogamy of two *nuclei* and not of two *polar cells*. These wrong data seem to come from the first edition of Soó's text-book on evolutionary taxonomy, page 264 which reads as follows: "Inside the nucellus the macrospore i.e. the embryo sac is found in which generally *8 cells* (not nuclei? — P. Greguss) *develop*". In fact *8 nuclei* develop in the embryo sac, from these later the egg apparatus with 3 cells, and further 3 antipodes develop, while in the centre the *central nucleus* (and not cell!) remains. The diploid *central nucleus* (and not central cell!) *is not produced by a sexual process*, as only the two sister nuclei join, while *in sexual processes always two cells or nuclei of different sex unite, then always a diploid cell division follows*, which, in the present case is absent. Accordingly, in the first sexual process the egg unites with one of the two male generative nuclei (or cells) of the pollen tube; it is from this union that later the diploid embryo develops; in the second sexual process the other male generative nucleus (or cell) joins with the female central diploid nucleus and becomes the first triploid *nucleus* of the endosperm. Reduction does not take place, however, on either occasion, because the triploid central nucleus continues to divide many times in the embryo sac, then each nucleus excretes a cell wall, and the tissue, thus produced, will be the triploid endosperm. This endosperm is used up by the embryo of the seed either entirely (e.g. beans) or partly (castor-bean). The presence of endosperm in Angiospermae may be considered as either progression or reduction, but its phylogenetic importance is much discussed.

(I do not give a longer list of references here, those interested will find them in my works and papers connected with this subject.)

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REFERENCES

GREGUSS, P. (1918): Ein Gedanke zur polyphyletischen Entwicklung der Pflanzenwelt. Beih. z. Bot. Centralbl., XXXVI, 229—269. Dresden

GREGUSS, P. (1919): Számtani törvényszerűség a növényország nemzedékváltakozásában (Mathematical rules of generation alternation in plants). Bot. Múzeumi Füzetek, 1919. III. 1. Kolozsvár, 17—21.

GREGUSS, P. (1922): Sporenverschiedenheit der Musci, Botan. Archiv. Königsberg, 473—480.

GREGUSS, P. (1964): The phylogeny of sexuality and triphyletic evolution of the landplants. Acta Univ. Szeged, 1—51.

GREGUSS, P. (1965): A szárazföldi növényvilág három irányú (trifiletikus) fejlődéstörténete (Triphyletic evolution of landplants). 1—46. Szeged

WHAT IS THE ROLE OF APOMICTIC FORMS IN ALTERNATION OF GENERATIONS?

The author may be asked to provide suitable explanations towards the following:

a) Apomitic forms;

b) 2N and 3N nature of endosperm tissue in the Gymnosperms and Angiosperms, respectively.

c) Capacity of the endosperm to differentiate (as has been shown in this laboratory), and form seedlings.

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ENDOSPERM AS THE THIRD GENERATION?

Author's ideas in relation with those included in the title can be summarized in three main points. In his paper author gives 1. an illustration of the well known phylogenesis of the alternation of generations in order to demonstrate the evolution of ontogenesis; 2. an explanation concerning the phylogenetical causes of the alternation of generations; 3. his ideas about a tendency to triploidy in the phylogenesis of the alternation of generations, the development of the third sex and third generation and its role, respectively.

1. At first sight the illustration seems to be ingenious and extensively usable, but after a more thorough examination it cannot be considered adequate. Illustrations of the phylogenetical tendency of the alternation of generations known from text-books, with the parallel representation of the alternation of generations at various developmental levels are simplified forms which show, however, similarities and differences quite well. Stieber joins the successive levels, thus wishing to illustrate the evolution of ontogenesis. This joining is, however, unreasonable as transitions are much more gradual than shown by him. Author mentions, though, that thousand million of ontogenetic levels ought to be illustrated, but it is, of course, impossible. Hence it is not the ontogenetic evolution but interlinked metagenetic types of the phylosgenetical levels that his figure represents. Thus his way of illustration does not mean a progress compared with the figures of text-books, especially with the spiral ones; moreover, linking of the individual types is misleading. Anyway, the alternation of generations occurring in the course of evolution could be illustrated in many other ways, e.g. with a columnar diagram (especially with that of vertical axis), circular diagram, biaxial system of co-ordinates, chess-board pattern (but why?).

In other words, it is inexpedient to over-simplify the text-book figures presenting highly simplified processes and making concessions for didactical reasons — as all generalizations do — concerning certain specialities (pertaining to genus, class, order, etc.), because they get too far from reality.

It is another question again — as it is indicated by the author himself — that the illustrations of such character do not show branching and rejoining, that is, the essential features of evolution that occur at the level of population and can be illustrated by a network pattern which would show the proper place and role of ontogenesis in the process of phylogenesis much better. Author says that to make such representation was not his intention, though — in my opinion — it would have been a better intention!

2. The explanation of the cause of metagenesis is in want of evidence. Documentation of results either described by the literature or obtained in his own relevant experiments is not included, thus the question cannot be discussed in effect.

3. Evolutionary progress of diploid generations is really well known. Nevertheless, interpreting the appearance of triploid endosperm as an ontogenetic tendency to triploidy and considering this endosperm to be the third generation, third sex, seems to lack any basis. It follows from an over-estimation of the phenomenon of the alternation of generations, a mechanical way of looking at it and an unconsidered generalization. Here again the scientific documentation of the problem (e.g. as to the great variability of the structure of the embryo sac, the varying morphosis of the endosperm), an adequate discussion of literature on the role of nutrient reserves are absent.

Author's statement as to the progressive character of taxons with seeds containing endosperm is worth paying attention to, because it partly points out the contradictions in the phylogenetic systems of Angiospermae, though here a secondary absence of endosperm has also to be reckoned with. In any case, it is thorough and detailed study of the literature and further investigations on the development of both seed primordia and seed tissues that may give really interesting and new results in this field too.

On this basis I do not think that author's concepts — apart from the way of illustration — can be really discussed in their present forms. Author's interesting suggestions compared with relevant results of literature as well as conclusive experiments, investigations and observations may render possible the acceptable publication of really new findings and results in this field.

*

For didactical reasons I feel bound to mention and discuss some terminological questions involved in the study independent of the basic ideas. Author does not explain what he means by the term ontogenesis, though his interpretation differs from the general use of the word. Instead of "alternation of generation" (Generationswechsel) he uses the term "periodical ontogenesis". Author considers haploid and diploid generations being successive ontogenetic phases (first three lines), while later (7—9 lines) he contradicts himself by giving primary role to the nuclear-phase change in producing the new individual.

In my opinion the term "alternation of generations" cannot be generally replaced by the one: "periodical ontogenesis". Namely, the haploid generations, as products of the vegetative reproduction mean entirely independent individuals in the cases of heteromorphic alternation of generations with reduced gametophytes, and of isomorphic alternation of generations. In shooted plants individuality or independence of gametophytes is gradually reduced. The extent of this reduction may practically approach the "gamete" level, but even in this case it cannot be considered to be the first ontogenetic phase of the diploid generation, just as gametes themselves do not belong to it. It is even more obvious in case of taxa with hetero-

spory of alternating sex. On the other hand, haploid or sexual and diploid or asexual stages of development can be unequivocally spoken of.

Certain German text-books often use the definition of alternation of generations being accompanied by a nuclear-phase change (Kernphasenwechsel). I think the term "nuclear-phase" is not properly used in this interpretation, as it reminds of phases of nuclear division. Author's translation is — in my opinion — not precise, since he uses the term "nuclear-phase change" (Kernphasentausch) instead of "nuclear-phase alternation" (Kernphasenwechsel), although no change (Tausch) occurs here! It is even worse when author uses nuclear-phase change (Kernphasentausch) instead of alternation of generations (although in the given case former is only a part of the latter phenomenon). Otherwise, Haraszty (Növénytan [Botany] I. 1968) uses these concepts properly by speaking of nuclear-phase alternation and sexual development phase (and not of ontogenetic phase).

Unfounded generalization, careless translation and terminological mistakes of the kind may have a disturbing effect on the educational work as well!

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ALTERNATION OF GENERATION OR PERIODICAL ONTOGENY?

With reference to the alternation of generations in plants Stieber's work is worth being paid attention from three aspects:

a) terminology,

b) alternation of generations as illustrated,

c) evolutionary interpretation of the alternation of generations.

Objections raised in connection with the first two items are obviously of less importance (some of them seem to be a captiousness), but even they often reflect a deficiency conspicuous in the third item (c), namely a complete lack or neglect of fundamental knowledge of evolutionary genetics. This is however, an indispensable requirement for any evolutionary interpretation.

My actual objections according to the above items are:

a) Can alternation of generations, or more precisely the life cycle be called "periodical ontogeny"? What is the period here? According to the author there are haploid and diploid "periods" in the life of the "individual". The concept of individual is seldom used in botany, since it cannot be easily formulated. On the other hand, in genetics the term "individual" is identical with Dr Stieber's "period", as the individual is "all the cellular derivates of one fertilization up to the succeeding meiosis, or all the derivates of one of the four spores produced by meiosis up to the succeeding fertilization". (Rieger, Michaelis and Green: A glossary of genetics and cytogenetics. Springer-Verl. 1968.)

The terms "gametic-" and "nuclear-phase change" (used by the author as cover-names for the haplontic and diplontic life cycles) are particularly misleading, as one might easily confuse them with the meiosis of a diplontic organism ("gametic") and the process of fertilization ("zygotic").

b) The "sinusoid" presentation (neither Fig. 1 nor Fig. 2 are sinusoids*) is merely a side view of Zimmermann's illustration of "hologenesis". On the other hand, the setting up of the

* The word „sinusoid" has somehow disappeared in the English translation in spite of the Editorial Board's statement on p. 205, second footnote.

system of coordinates destroys its original meaning completely. What is the reason e.g. for the *gradual* rising and falling of the *curve* in the function of the vertical axis (ploidy level)? There is no gradual change — by gathering the chromosomes piece by piece — as the plant reaches the diploid level and vice-versa. Thus longer or shorter horizontal bits rising and falling vertically in right angle ought to be illustrated instead. Besides, after the point of intersection, at the other ploidy level, the curve is continued in a single line or a pair of lines, and this does not correspond to the actual situation. In an "evolutionary interpretation" in Fig. 2, this is very misleading, and covers only the concept of "teleological" evolutionary orthogenesis, supposing that in each life cycle an evolutionary progress took place in a definite direction.

The 3n level shown in Fig. 2 may be completely misunderstood. It suggests that in the life cycle of the *Angiospermae*, at the culminating point the diploid phase changes for 3n triploidy, then returns to the diploidy again and later to the haploid phase. In the plants however, — as it is certainly very well known by the author — the triploid "generation" starts from the haploid one, and the diploid level is represented by a single cell only. Further, the triploid level can never change back for diploidy. (Diploid, pentaploid and polyploid endosperm will be discussed later.) Otherwise, in Fig. 2 there is no horizontal axis. On the basis of Fig. 1 this would be the axis of time. On the other hand, how can the author explain the meaning of the waves iniciating from the left in Fig. 2 and do not reach the 2n level?

c) The most serious problems in Stieber's paper are raised about the evolutionary interpretation. The rich literature on this subject has not been used and probably not even known by the author (see e.g. G. L. Stebbins: The comparative evolution of genetic systems. — In: Evolution after Darwin. I.: The evolution of life. — The Univ. Chicago Press, 1960. — with abundant references up to 1959). Author tries to explain* the origin of the alternation of generations and sex respectively by "periodical changes in the life conditions and ecological factors", and does not even mention its well known evolutionary genetical basis (e.g. recombination, variability). He states that "sexual processes occur in most cases when conditions become unfavourable" with the primitive algae. On the other hand, scientists culturing algal strains can prove that sexual processes take place here under definite optimal conditions only. The origin of sex is, thus, by no means as simple as that, and to understand it, the primitive sexual processes of bacteria and their genetic background ought to be known. (Wenrich wrote about 263 hypotheses concerning the origin of sex in 1954, so to-day there must be at least 264.)

One of the main points of Stieber's paper is that he believes in the "phylogenetic predominance of the tendency to polyploidization within ontogeny" in plants (see Fig. 2). He points out that the diplontic types are progressive, and instead of explaining why, he simply says that this is a general tendency, a rule of evolution. What else is this if not teleology? (The author denounces Zimmermann with !) What is more, Stieber tries to force the triploid endosperm to fit into his "rule". He considers it as a third generation produced by the participation of a third sex (!) and appearing necessarily in the course of evolution. It is a pity that the author does not mention those types of *Angiospermae*, where the endosperm is only in the "less progressive" diploid "period" *(Oenothera)*. In Fig. 2 "periods" of types with "well developed" pentaploid (e.g. *Fritillaria)*, "highly developed" 9× (e.g. *Acalypha)* or "even more developed" 15× *(Peperomia hispidula)* endosperms are to be included and illustrated (how?), the last of which is evidently supposed by the author to have as many as 15 sexes !? Is it not that cells and tissues connected with nutrition can perform their functions more perfectly as polyploids?

* Dr. Stieber's reasoning is sometimes surprising. A good example is his third sentence: „As nuclear phase change plays a dominant role in the formation of new individuals and thus in the *perpetuation* of the genus or the category, it is obvious that the alternation of generations is a substantial driving force and form of manifestation of *phylogeny*." (My emphasis.)

That is why these types have developed in the course of evolution. This explanation is supported by the tapetal cells of fern sporangia which are often polyploid, the fusion of nuclei observed in macroprothallia of *Gymnospermae*, or the highly polytenic chromosomes known in the salivary glands of *Dipter* and also in some glands of certain plants.

Polyploids not being always progessive is proved — among others — by the fact, that one of the most primitive living fern species *(Ophioglossum reticulatum)* has the highest number of chromosomes and — supposedly — a high polyploidy level. Adventages and disadvantages of haploidy, diploidy and polyploidy can satisfactorily be interpreted on the basis of our knowledge of genetics explaining the fact that many living creatures — often of pioneer character — have retained the haplontic or gametophyte-dominant life cycles (see Stebbins: Variation and evolution in plants. Columbia Univ. Press, 1950), while in others the diploid sporophyte is dominant.

It is a mistake to deduce isomorphic alternation of generations from the haplontic types with *gradual* transition, as there is convincing evidence for the origin of isomorphic alternation directly from the haplontic simply by suppressing of meiosis at the time of germination of the zygote (for references see Stebbin's work [1960] cited above). The rather scarce "transitional form" in certain algae and the mosses probably derived from isomorphic types. Induced apospory and apogamy experiments performed with mosses and ferns as well as morphological observations made on *Psilotum* species confirm this hypothesis. The abundance of isomorphic life cycles in algae can hardly be explained with gradual transition. It is a frequency of transitional forms that could be expected instead. Thus Fig. 2 does not correspond to our up-to-date knowledge and can hardly be considered evolutionary. Only a short section (from the isomorphic type to the appearance of 3n) can be accepted — with the previous objections (under item *b)* maintained. This has been, however, generally known for a long time (the reduction of the haploid generation from ferns to flowering plants).

To sum it up it can be concluded that a comparative study of such a general biological phenomenon as life cycle — especially its evolutionary interpretation — requires a wide knowledge of the subject. The seriousness of the subject does not permit — even at a "preliminary" level — the neglect of evolutionary knowledge, as it may lead — as proved by the paper in question — to the development of false ideas. Finally, I should like to emphasize, that I made my comments only on the repeated request of the Editorial Board.

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IS SEXUAL UNION NOT ONLY THE EQUATION OF REDUCTION?

In his paper author conveys some very interesting suggestions on the subject which are worth being discussed.

Author is undoubtedly right in expressing the process in question with a sine curve, since in the course of alternation it arrives at a similar and not at the same state as it has been previously, while time has passed. This statement apparently originates from the fact that, due to practical and didactical viewpoints and for the sake of a better understanding, all textbooks and wall-boards show the process in the form of a circle as it is the simplest way, while its illustration with a sinusoid would be much more complicated and would require more space.

Author is also right in suggesting that forms representing the persisting stage may be produced under the influence of external conditions becoming unfavourable and nutrient

reserves depleted; in my opinion, however, not every persisting cell or organ fits in the process connected with nuclear-phase-change, on the one hand; sexual processes, reductive division are not necessarily connected with the decreased nutrient content, thus cannot be related with evolution (in case of seedy plants, e.g. it is the other way round: reduction occurs in the very stage of nutrient abundance). I do not understand on what basis author says that sexual union is not only the equation of reduction.

Author is right — furthermore — in speaking of "three sexual processes" in the case of *Angiospermae*, nevertheless I do not consider it appropriate to compare it to the *Rhodophyta*. On the other hand, secondary endosperm cannot — in my opinion — be considered to be the third phase, as it appears simultaneously (and not alternately !) with the egg cell, and is present only as a tissue serving for nutrient accumulation, does not continue developing or entering another phase, on the contrary, later, with nutrient reserves consumed perishes. In spite of being the result of a separate karyogamy it can be considered as a triploid appendix belonging to the diploid embryo produced at the same time. Periodicity is characterized by alternation, by successive productions taking place at different times; this — in my opinion — cannot be told of the secondary endosperm due either to its synchronous formation or to the fact that it does not turn into another, a nuclear phase.

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ALTERNATION OF NUCLEAR PHASE OR ALTERNATION OF GENERATION?

Under the title "Preliminary studies" author presents several ideas which are — owing to the nature of the subject — necessarily related to each other. The — often very complicated — phenomena in question have been known and investigated for a long time. So, owing to the divergent interpretations of concepts and for lack of precise definitions not only terminological problems have been arisen in the course of time but also a considerable confusion of principles has been brought about.

The paper covers a wide range of problematic subjects. Its preparatory character and restricted size are, however, bound to prevent a thorough explanation of details, which is a regrettable fact, for the subject can thus be treated only in such a general way as to make any real discussion hardly possible.

Having read the paper and having had a personal talk with the author, I think those considered by him as new findings can be summarized as follows:

1. Illustration.
2. Explanation of causes starting the sexual process in the course of phylogeny.
3. Stress laid on the importance of zygote formation as opposed to the earlier emphasized meiosis.
4. Phylogenetical interpretation of the development of endosperm.

Prior to expressing my opinion on the questions enlisted I have to mention that it is only later that I wish to deal with terminological problems, as they are not important from the point of view of evaluating the paper.

1. The way of illustrating the alternation of generations (Fig. 1) can be considered as new, at least in this scope of subject. The curve cannot, however, be called a sinusoid,* namely,

* There is a difference between the Hungarian manuscript and the printed English text in this respect: my criticism refers to the former which contrary to the latter, has mentioned the curve explicitly as "sinusoid".

in latter case different y-values would belong to each point of the x-axis. Since the upper half wave is entirely in the haploid domain, in this interpretation it should be a straight line parallel with the x-axis rather than a curve. And then we come back to the old linear illustration (Strichschema). In my opinion Stieber's method of illustration has nothing to do with the sinusoid (with the position of the y-axis changed it could be even called a cosine curve), instead it is a modification of the old "Strichschema", where the height and width of waves are arbitrary and only of symbolic importance, and do not express a function. Illustration of metagenesis has first of all a didactical importance. Its frequently used circular illustration is not wrong if the only aim is to present conditions following each other in the course of the ontogenesis. Author also says that ontogenesis is not a regressing process but one in which conditions similar to the initial condition occur. (It is absurd to imagine a literal regression!)

2. Evidence given on factors developing sexual reproduction in the course of evolution cannot be considered satisfactory. Knowing the genetical, moreover molecular biological interpretation of the process of cell division it seems too simple to explain the development of such a complicated mechanism by mere environmetal effects. Sexual reproduction is a general feature of all developed groups of cellular structure, the role and development of which is properly evaluated only when the conclusions are equally valid at every level. A theory providing an acceptable explanation based on and corresponding with the molecular biological knowledge is needed.

Questions of the alternation of generations and of the nuclear-phase-change cannot be phylogenetically evaluated and illustrated in the way Fig. 2 shows. Large units are more or less well separated even from a phylogenetical point of view. They can — at the most — be put side by side, compared with phenomena occurring in the course of ontogenesis so that primitive and evolved characters could be distinguished. It is, however, impossible to explain evolution or its general tendency by placing units in a continuous line the more so, as tendencies in the individual groups may have manifested themselves in different ways.

It is not the only reason Fig. 2 can be criticized for. Although author says that it is not his task, still he would give more information if he indicated the conditions of amphi- or apomixis so much important from the point of view of evolution, or the mono- and polyphyletic (-topic) origin, respectively. The high degree of generalization does not demand such details, however, it is just for its general character that Fig. 2 is meaningless and misleading; evolutionary relation is not apparent either among the large taxonomic groups or among their methods of metagenesis. What is it fit for, then?

3. This point is not clear in author's formulation either, though similar opinion has already been expressed, e.g. by WIDDER (1951 p. 255) — only without a phylogenetical interpretation.

Otherwise the question: which of zygote formation and meiosis is the primary process? is very like that of what existed earlier, hen or egg.

Sexual reproduction, as a process making the organization of living beings possible and ensuring the development of new structures in the course of phylogeny, should ultimately be explained on biochemical and energetical bases as to its origin as well.

4. The paper does not quite clarify the phylogenetic explanation of a presence or absence of endosperm in seedy plants, first of all Angiospermae either (absence of endosperm may be either a primary or an evolved character); in my opinion this would be the most valuable thesis of the paper, but it requires further detailed elucidation.

*

Objection can be raised to the missing literary survey and critical evaluation, first of all in connection with the alternation of generations. Confusion and misunderstanding in this question have been mostly brought about by the fact that various text-books often contain

quotations and statements obtained from other than original sources. I wish to mention but a few problematical questions without intending to discuss here the subject exhaustively.

It is well known that "alternation of generations" is a misleading term, as it has a different meaning in everyday language (not only in English but also in other languages). Still it is widely used, because when specialists discuss this phenomenon they know what they are talking about. It is better to employ an established wrong term in right interpretation than to introduce a new but similarly wrong one. It is in this sense and with this reservation that the term "nuclear phase alternation" (and not change!) can be used. What is, after all, ontogenesis? Ontogenesis or ontogeny is the history of development and growth of an individual (HENDERSON 1957). The concept of individual is problematic first of all with plants if sporophyte and gametophyte are separate plants. They have separate ontogenesis which makes a whole life cycle by following one another. The term "biont alternation" (Biontenwechsel) is also used. Biont = an independent living organism, an individual organism (HENDERSON 1957). What does generation mean? Can zygotes and gametes be considered as generations not to mention persisting or other reproductive cells which also possess some sort of independent individuality?

WIDDER's thorough study (1951) in which he points out the absurdities and errors of various opinions gives answer to similar questions.

The various ontogenetic states and their sequence — with obligatory and sometimes facultative states inserted — are characteristic of the group. These complicated phenomena have been investigated, described and interpreted for a long time; often no difference is made among them, or one is mistaken for the other, because precise outlining of the aim and subject of investigations is neglected. So nuclear phase alternation is often not only mistaken for alternation of generations but also considered by some authors to be the same. Many synonyms have also been created. If questions are to be clarified, we must not forget that the phenomenon can be examined from more than one aspect of ontogenesis: e.g.

1. What are the various states of development, what is their sequence! (from an arbitrary starting point to the same state).

2. How and when does the cytological state change during the ontogenesis? (Nuclear phase alternation.)

3. What kind of habitual changes occur during the ontogenesis; are they accompanied by functional changes as well?

4. What trends does individuality show during a whole life cycle?

Misunderstanding and confusion developed in the course of time in relation with the alternation of generations can be settled by raising of these and similar questions. It is only under these conditions that an up-to-date evaluation of relevant problems may contribute to a successful phylogenetic research work. Last but not least, questions have to be settled from a didactical point of view as well. Currently used Hungarian text-books also should be revised in this respect.

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REFERENCES

HENDERSON, I. F.—HENDERSON, U. D.—CENNETH, I. H. (1951): A dictionary of scientific terms. Nostrand, Toronto—New York—London. 6th ed.

WIDDER, F. (1951): Grundformen des pflanzlichen Phasenwechsels. Phyton (N. O. Austria), **3**, 252—272.

COMMENTS ON RAJKI'S AUTUMNIZATION EXPERIMENTS

My paper: "Commentary on the book Autumnization and its genetic interpretation by S. Rajki" published in No. 3—4, 1969 was answered by Rajki without any delay. This fact is even more flattering because — as far as I know — this is the first critique publicly answered by him. This quick reaction as well as the fact that he calls all my objections "incorrect" oblige me to give more detailed reasons for my observations, and at the same time I wish to make some remarks on Rajki's answer.

First of all, I want to clearly formulate my opinion about the possibility of adequate genetic variations occurring under environmental influence: Possibility of "*adequate*" hereditary changes caused in higher plants by climatic factors acting during the ontogenesis has not been proved by *incontestable* experiments so far. This, of course, does not mean at all that environmental factors of that type have never induced adequate hereditary changes. This fact might soon be demonstrated in reliable experiments. However, at the present state of science no hypothesis can be maintained for years in a field where the contrary of the hypothesis seems to be reliably proved. My conviction is not influenced by any prejudices, only I cannot accept statements that I consider as not properly proved.

No doubt, anyone who succeeds in demonstrating *adequate* hereditary variations caused in higher plants by environmental factors will do a good service to genetics, especially to evolution genetics — and also to applied plant breeding.

It is a generally known fact that the possibility of Aristoteles' "generatio spontanea" could not be entirely excluded for more than two thousand years, as long as *reliably sterile conditions could not be created.* As soon as it was realized, no one ever doubted that the old hypothesis had been wrong. If somebody wanted to prove anew the possibility of spontaneous generation *would have to carry out the experiment under reliably sterile conditions*, otherwise no one would give credit to the evidence, however attractive the subsequent control tests he performs should be.

The hypothesis of acquired characteristics being hereditary is a similar case. On the basis of wrong or superficial observations this hypothesis was thought to be proved over far more than two thousand years. However, as soon as in genetic studies "*sterile conditions*" were provided for, that is the possibility of genes existing in homozygous state became known, the evidence of acquired characteristics being heritable ceased to be effective. According to the present standpoint of genetics, a homozygous state can be changed under natural conditions either by spontaneous mutation or by spontaneous crossing only. Thus, anyone who wants to prove now the adequate hereditary influence of environmental factors acting during the ontogenesis *has to provide for "sterile" conditions, that is, produce a homozygous state for the character the changing of which he wishes to demonstrate.*

Rajki is right in pointing out in his answer that I am not sure that the *absence of a claim for low temperatures* was in a homozygous state in the initial material of Lutescens 62. This highly reasonable doubt is based on the fact that in the genom of the hexaploid wheat winter and spring characters respectively are determined by at least three major gene-pairs (UNRAU 1950, SEARS 1954, KUSPIRA—UNRAU 1957), and the closely related character: the length of the vegetative period is influenced — according to KUSPIRA—UNRAU (1957) — by the interactions of further 10 gene-pairs. It is highly improbable that such a complex character could be present in a homozygous state in each individual of a material collected unisolatedly. This doubt ought to have been settled by all means, but the initial material of the first two experimental cycles consisted of plants originating from unisolated test plots. The so called "strict pedigrée selection on single plant basis" without isolation may meet the requirements of practical plant breeding, but is entirely unsatisfactory for the purposes of an exact genetic

experiment, especially when latter *sets up the claim of demonstrating a fundamental genetic principle.*

It is for the same reasons that I criticize Rajki having started from an "allohexaploid" species that made it superficially difficult to attain the homozygous state. He ought to have performed his experiments with tetraploid wheat or barley or oats at least. With tetraploids the homozygous spring character could have been ensured much more simply.

The basic material of the third experimental series consisted of plants *isolated but once*, and though the further generations were also isolated, a *single pre-isolation* cannot be considered satisfactory due to the polygene origin of the character. Although the subsequent isolations excluded the possibility of outcrossing, they could not alter the situation if the homozygous state of the initial material was doubtful, since *autumnization began with the grain yield of plants isolated on one occasion.*

The fact that reliability of the first two cycles had been doubted by Rajki himself was proved by a sentence saying that he had taken into consideration the experiences and shortcomings of the first two cycles as well as the theoretical and methodological objections when starting the third cycle (see p. 459, lines 13—16.). Thus in the autumn of 1962 shortcomings and objections were already pondered, *but why only in 1962, why not in 1955?* According to the evidence of the book papers by Skripchinski, Vavilov and Kuznetzova, Rédei, Győrffy, Váróczi and Makó were well known to Rajki in 1955, not to mention Stubbe's results published also in 1955. So if the author knew the methodological objections and also knew that a conclusive genetic experiment had much stricter conditions than those of a breeder's selection why did he carry on for *seven years* experiments in which these conditions were overlooked. This cannot be understood and it is my unfortunate duty to repeat here the statement I have made in the introduction. In case of non-sterile conditions, that is non-homozygous state, any posterior evidence is of hypothetical value, since it does not use the same material as used initially. If between 1955 and 1962 the author *had grown 9—10 generations earing earliest at a constant mean temperature of 15 °C, and started in 1962 from this material, he could have avoided all the objections mentioned before.*

In the second part of his answer Rajki summarizes the controversary existing between us by saying that I think the occurrence of spontaneous mutation possible. He refuses the probability of spontaneous mutation on the basis of a gradual transition observed by him between spring and winter character. It is well known, however, that graduality excludes the possibility of mutation only if we think that with characters of polygene origin mutation can be brought about only when all genes taking part in the development of the characteristic in question mutate simultaneously. This may sometimes happen, and then the change is really sudden, but now we know only too well that it is not sudden mutation that is typical. Minor genes mutate *much more frequently* and may give the impression of a gradual change. Almost the whole evolution is the result of such micro-mutations. That is why I wonder, further, why Rajki did not even try to find out what is the spontaneous mutability of the spring type Lutescens 62 like, although there would have been plenty of occasions during the 10 years. As long as no data are available on this question, any mutation frequency can be imagined.

In addition to the failure to make the absolutely necessary preparations aimed at attaining the homozygous state of the initial material I have the following censures: the population was subjected to a constant selection pressure; numerical relations are mostly unknown or else, potential population was not taken into consideration; other genetic variations were also produced, which suggests either mutation or uncontrolled crossing; finally, there were varieties that could not be autumnized. It is true that the author wanted to autumnize the Italian varieties for breeding purposes, but they were not mentioned later, although if he had succeeded in that work such varieties should have been either produced or at least mentioned.

The obstinate resistance of the wheat variety Marquis is another problem. If there is an adequate autumnization it must be able to transform any spring or "semi-winter" wheat.

The reason why I decided to write the commentary is that the reflectios published by the foreign press clearly indicate that most of those reading the book have neither time nor possibility to study the papers referred to. On the other hand, the book did not give a full survey, only selections of the data of the 10-year experiment series. It is true e.g. that on page 22 of the book the following passage can be found: "(c) the use of grains originating from spikes flowering under an isolator for both the winter and spring sowing (only in cycle III) . . ." This part in brackets was considered by the author to be enough to say that in seven of the ten years of experiment not one of the spikes was isolated. If this momentum is only as important as that, in the question of demands made on genetic experiments there is a great difference between us. Namely, this momentum would require a thorough explanation, especially when we take it into consideration that Skripchinski's and others' standpoints were already known in 1955.

The reviews make it clear that the critics do not consider the results of the ten years' experiment at Martonvásár satisfactory. In my opinion, with this method no such convincing evidence as being able to shake any point of the currently accepted basic genetic concept can be furnished, although they may partly be wrong. The problem has to be approached to from a different aspect and with different methods. The question whether this task is proportioned to the Institute of Martonvásár, is to be decided on by others. No doubt, science is expecting the new results as they are expected in practical breeding work as well; but no one should take it ill if, owing to the great importance of the problem, we are highly critical about the evidence. The aim is to throw light upon the scientific truth rather than have argument at any price.

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REFERENCES

KUSPIRA, J.—UNRAU, J. (1957): Genetic analyses of certain characters in common wheat using whole chromosome substitution lines. Canadian Jour. Plant Sci., **37,** 300—326.,
SEARS, E. R. (1954): The aneuploids of common wheat. Univ. Mo. Agr. Exp. Sta. Res. Bul. 572—590.
UNRAU, J. (1950): The use of monosomes and nullisomes in cytogenetic studies in common wheat. Scientific Agric., **30,** 66—89.

ONCE AGAIN ABOUT THE DIFFERENCE IN OPINIONS CONCERNING AUTUMNIZATION

LELLEY's reply (1970) in which he reflected to my answer "Difference in opinions concerning autumnization" (RAJKI 1969) given to his "Commentary . . ." (LELLEY 1969) published on my book "Autumnization and its genetic interpretation" (RAJKI 1967) suggests that he continues to cast doubts on evidences concerning the homogeneity of spring growth habit in the initial stock of our autumnization-genetic experiments, and — in opposition to my interpretation — thinks it possible to explain autumnization by spontaneous mutation. Lelley has, of course, the right to do so, and his doubts all the more stimulate me, the researcher, to produce even more convincing evidences. I hope that the results of the second decade of research programme published so far or to be published on the manysided genetical, cytological, bio-

chemical and physiological etc. experiments, will better satisfy Lelley than those of the first decade do.

From Lelley's reply I see, however, that my paper "Difference in opinions concerning autumnization" did not completely fail to influence the genetic views of my opponent. Namely, in his reply Lelley, while — as he writes — clearly formulating his opinion about the possibility of adequate genetic variations caused by environmental factors — does not exclude the possibility of such genetic variations. Moreover, he admits that "anyone who succeeds in demonstrating *adequate* hereditary variations caused in higher plants by environmental factors will do a good service to genetics, especially to evolution genetics — and also to applied plant breeding". And this can really encourage us, since even in Lelley's opinion some points of "the currently accepted basic genetic concept . . . may partly be wrong". If so, is it possible that a repeated study of the autumnization-genetic publications serving as a basis for present discussion, as well as of my book "Autumnization and its genetic interpretation" and other successively published papers on the subject would further reduce even Lelley's doubts?!

While studying the relevant literature Lelley — in my opinion — certainly should not forget that the word "incorrect" in my paper "Difference in opinions concerning autumnization" refers to concrete Lelley statements. And this — according to the rules of correctness obligatory to everybody in science — cannot be settled with the remark "he calls all my objections 'incorrect'" made by him in his reply. For the same reason Lelley's scientific position is certainly not consolidated by the wrong or incomplete references to "Difference in opinions concerning autumnization" in his reply. So it was not for the gradual transition observed between spring and autumn habit that I dismissed the possibility of spontaneous mutation, as I wrote: „. . . . the category of mutation is not applicable to autumnization as a non-random, but as an adequate conversion corresponding to the inducing circumstances." Then I continued: "Notwithstanding, with great interest would I study a precisely expressed explanation for autumnization as adequate genetic conversion, based on the concept of information genetics and thought to be correct by Lelley." Such interest from my part seems, however, to require from Lelley a further study of the problem.

Such remarks of the reply as "this is the first critique publicly answered by him", "other genetic variations were also produced", "If there is an adequate autumnization it must be able to transform any spring or 'semi-winter' wheat", "The book did not give a full survey only selections of the data of the 10 years experiment series" also show that Lelley knows his opponent's arguments and papers only superficially, and for the sake of a fertile discussion he had better take the teaching of the Latin saying "*Repetitio est mater studiorum*" seriously. If he does so, he certainly will make such remarks as requring strictly relevant, substantial answers.

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REFERENCES

Lelley, J. (1969): Commentary on the book "Autumnization and its genetic interpretation" by S. Rajki. Acta Agronomica Acad. Sci. Hung., **18,** 455—458.
Lelley, J. (1970): Comments on Rajki's autumnization experiments. Acta Agronomica Acad. Sci. Hung., **19,** 459—461
Rajki, S. (1967): Autumnization and its genetic interpretation. Akadémiai Kiadó, Budapest, 88.
Rajki, S. (1969): Difference in opinions concerning autumnization. Acta Agronomica Acad. Sci. Hung., **18,** 458—462.

Acta Agronomica Academiae Scientiarum Hungaricae, Tomus 19 (3—4). pp 435—445 (1970)

LECTIONES

THE MODIFICATION OF PROTEIN QUALITY OF MAIZE BY BREEDING*

The quality and quantity of maize protein has received the attention of plant breeders and animal nutritionists for almost three-quarters of a century at the University of Illinois. But despite the effort, it remained for the team of BATES—MERTZ—NELSON (1964) at Purdue University to make perhaps the most significant plant breeding discovery of the first three-quarters of the 20th century, the discovery that storage proteins of the endosperm need not be of low biological quality. Perhaps we are still too close to the discovery to properly put it in perspective, but intense interest has been generated not only among maize and other cereal breeders but even among politicians throughout the world. It seems likely that a new and important interest has been generated which will support experimental plant breeding for a very long time.

Some negativism exists among American maize breeders about the future of modified protein corns. These individuals look upon early research results as precursors of very bad news. Maize processors also have been disappointed because the grain is illy adapted for their processing machinery.

To give perspective to these views, let us assume that man had domesticated wild corn carrying the $^{o}2$ allele instead of the dominant one. He most certainly would have selected variants of many kinds, the species would have spread throughout the New World and have been adapted to various ecological niches just as dent and flint varieties did in reality. Thus a "Southern Shoe-peg Opaque-2" and a "New England Opaque-2" could have resulted. The crossing of these two open-pollinated varieties would have produced "Reid Yellow Opaque-2", "Lancaster Opaque-2", etc. Thus, we might have found ourselves in 1963 not knowing that maize need have biologically defective endosperm proteins, and as a matter of fact, it would probably not have been necessary to depend on the soybean for protein in the United States Corn Belt. Surely geneticists would have found and preserved the dominant allele and it would have been carried in the Maize Genetics Cooperative at Illinois as another "useless" mutant. Had Mertz, Bates and Nelson been searching for endosperms high in zein because it would make better bourbon whiskey, they would doubtlessly have identified "Dent" as being a desirable mutant. Consider the problems breeders would now be trying to solve. Backcrossing programs would be devoted to convert opaque-2 inbreds to dents. Low yielding experimental dent hybrids could be commonplace. The millers would be complaining about the hardness of the kernel and the small amounts of corn flour produced from it. Great interest would be expressed by all bourbon drinkers because the new product would be expected to have a light and delectable flavor.

Although this little comedy is an exercise in exaggeration, it should make clear our conviction that five years of breeding work on modified protein maize is an extremely short

* Read at the 5th Meeting of Maize-Sorghum Section, EUCARPIA, Budapest, Hungary September 2, 1969.

time to have spent and still expect revolutionary results. Ten thousand generations of selection in populations essentially homozygous for the dominant opaque-2 allele most surely would have accumulated modifier complexes that would be less desirable in a homozygous recessive population. To except otherwise is to ignore that plant breeding is an evolutionary process and no amount of biological manipulation can be substituted for selection over substantial periods of time.

With the meager data now available, we can be optimistic that several tens of generations of selection will solve most of the problems we now see with modified protein maize. Certainly no biologist today believes that maize endosperm proteins need be largely zein. Breeders throughout the world know that modified protein corns can be produced and if for no other reason, success can be predicted solely on the basis of the magnitude of their efforts.

Salient problems and solutions in the improvement of maize protein quality

Experimental work with the opaque-2 mutant has been underway since 1964 at Illinois. In 1966 a series of normal single crosses and their opaque counterparts were tested at Urbana. Trials have been conducted since that time and considerable practical experience has been accumulated. As a result, we recognize certain problems with modified protein corns and are attempting to solve some of them.

Yield. Opaque-2 hybrids generally are lower in yield than dent hybrids. Several critical comparisons have been made at Illinois. In the earliest attempt (ALEXANDER—LAMBERT—DUDLEY 1969) kernels of backcross-one selfs of seven standard lines were divided into normal and opaque groups. Systematic sets of single crosses were made within the normal group and within the opaque group. Thus, nearisogenic versions of the same hybrid were produced, one homozygous for the recessive opaque-2 gene, the other carrying the dominant allele at a frequency of 0.66. The hybrids were tested at Urbana in 1966 in a 3-replicate split plot trial. The opaque-2 hybrids, on the average, yielded 85% of the normal counterparts although only 5 of the 17 hybrids yielded significantly less than the normal version. Backcross-four recoveries of the same seven lines were tested in 1967. The opaque-2 hybrids yielded 92% that of the normal hybrids. The improvement in performance of the opaque-2 hybrids presumably was a consequence of two more generations of backcrossing. LAMBERT *et al.* (1969) compared backcross-one, opaque-2 and normal lines in combination with two single-cross testers at two locations in 1967. Trials were planted and harvested by machine, thus approximating methods used by farmers. The results of these trials are summarized in Table 1.

The opaque-2 hybrids averaged 8% less in grain yield than the normals. However, two opaque-2 hybrids were significantly higher in yield than their normal counterparts, whereas eight were significantly lower.

The foregoing data lends some optimism to opaque-2 breeding programs in that they suggest satisfactory yields can be obtained. One might expect that extended backcrossing and selection would be essential to minimize the presumed deleterious effects of chromtin a closely linked with the recessive opaque-2 allele. Yet in four backcrosses, satisfactory performance was encountered.

Kernel hardness. Typically, opaque-2 and floury-2 have soft, low density endosperms. This quality poses problems, particularly to an agriculture based on machine harvesting and grain handling. LAMBERT *et al.* (1969) found that combine harvesting of opaque-2 hybrids resulted, on the average, in twice as much kernel damage as with normal hybrids (Table 2). In our early work we noted substantial differences in kernel hardness and texture in the few backcross progenies we studied (ALEXANDER 1966). PAEZ *et al.* (1969) have recently reported that mosaic opaque-normal kernels in several inbreds have similar lysine content to that of

Table 1

Yield of backcross-1, opaque-2, and normal versions of three-way crosses grown at two locations in Illinois in 1967

Hybrid	Tester	Inbred							
		B63	C121E	C144	H49	Mo17	Oh7N	R109B	Va36
		Quintals/hectare							
R810 × R802 (Normal) ...	60.7	73.2	66.0	72.3	73.3	75.5	71.4	61.4	65.8
R801 × R802 (Opaque-2) .	59.1	65.4	64.6	62.1	67.6	51.5	67.4	60.4	55.7
R802 × R803 (Normal) ...	68.9	54.4	54.6	61.0	69.5	56.0	63.7	60.0	51.1
R802 × R803 (Opaque-2) .	59.1	61.0	60.3	56.4	53.1	47.8	59.3	61.9	54.3

Bayes lsd = 5.5 at the 5% level of significance for individual hybrid comparisons

Table 2

*Comparison of backcross-1, opaque-2, and normal counterparts of three-way crosses and their single-cross testers for seven traits averaged for two locations**

Hybrids	Description	Quintals/ha	% moisture in grain	% erect plants	Wt. g/100 kernels	% cracked kernels	% oil	% protein
R801 × R802	(Normal tester)	60.7	20.0	63.6	29.4	3.4	5.5	11.0
R801 × R802 × Line .	(Normal)	69.9	21.0	71.7	30.3	3.8	5.3	10.1
		*	*		*			
R810 × R802 × Line .	(Opaque-2)	61.8	25.4	71.2	29.1	7.9	6.2	10.5
R801 × R802	(Opaque-2 tester)	59.1	23.4	72.1	27.0	4.8	6.0	11.0
R802 × R803	(Normal tester)	68.9	19.6	65.8	29.8	4.7	5.4	10.6
R802 × S803 × Line ..	(Normal)	58.8	20.7	70.2	30.5	3.8	5.3	10.5
		*	*		*			
R802 × R803 × Line .	(Opaque-2)	56.7	25.2	72.0	28.8	7.9	6.0	10.5
R802 × R803	(Opaque-2 tester)	59.1	22.3	78.2	27.1	7.3	5.9	10.1
Average Normal ...		64.3	21.0	71.0	30.4	3.8	5.4	10.4
		*	*		*	*	*	*
Average Opaque-2 ..		59.3	25.2	71.7	29.0	7.2	6.1	10.6
Average difference ..		−5.0	+4.2	+.7	−1.4	+3.4	+.7	+.2

Means with asterisk between them are significant at the 5% probability level.
* Lambert *et al.:* Performance of new maize hybrids.

classical opaque kernels. They suggest that selection for mosaicism can produce kernels with greater density and presumably with more resistance to harvest and handling damage. LAMBERT (unpublished data) of this laboratory, found great variability in kernel density in two opaque-2 synthetic varieties with some segregates having densities comparable to dent hybrids.

NELSON (1969) reported that the double mutant $o_2o_2 fl_2fl_2$ had a texture substantially different from the ordinary opaque-2 or floury-2 phenotypes. Lambert's (unpublished data) findings corroborate Nelson's early report, but he found several segregates as soft as ordinary opaque-2 kernels. Thus, if the double mutants were used to solve the hardness problem, it would seem probable that modifiers would be involved as well.

We believe that selection for increased density in broad-based opaque-2, floury-2 or double mutant synthetics should be successful.

Germination. Many breeders have found that opaque-2 maize does not germinate and survive as well as normal dent corn in cold, wet soil. Dr. N. P. Neal of Wisconsin cold-tested opaque-2 and normal counterparts of five of our inbreds (ALEXANDER 1969). Opaque-2 kernels, on the average, had a cold test germination percentage of 44% and the normal versions, 88%. However, the opaque versions of two lines (M14, R803) compared favourably (91% vs 98% and 89% vs 93%, respectively) with normal counterparts, thus establishing that opaque-2 maize could germinate and survive even under unfavourable circumstances.

Maturity. Abundant evidence exists that opaque-2 hybrids are higher in kernel moisture than their normal counterparts, particularly in the early part of the harvest season (Table 2). Whether the difference is substantial as moisture approaches 16—18% is not known by us, although some breeders believe that the loss of water is somewhat more rapid in opaques than in normals. Nevertheless, the higher moisture content of opaque-2 maize in the 20—28% range confers considerable disadvantage if early combining is to be carried out.

The importance of the lysine-protein ratio

Certain misunderstandings exist today about the numerical values used to express protein quality in maize. Since lysine is the first limiting amino acid of whole corn in non-ruminant diets, most attention is paid to it although tryptophan is limiting as well. MERTZ *et al.* (1964) were interested in endosperm quality, hence their first paper dealt with lysine in that tissue. Most practical breeders today are interested in the quality of the whole grain and hence lysine values usually are quoted on that basis. Since the embryo carries about 20% of the protein of the whole kernel, and since it is high in lysine, whole kernel data almost always show higher lysine levels than those of endosperm. Lysine content is usually expressed as percent of protein or as percent of dry matter. To overlook the manner of expressing lysine value can lead to misunderstanding. For example, if the L/P (lysine/protein) ratios are identical in two stocks, but the protein content is 50% greater in the second, the lysine/dry matter ratio will appear to be much more favourable in the second strain.

The effect is illustrated in Figure 1. The lines connect iso-lysine/dry matter levels. For example, should an animal require 0.5% of the total intake as lysine, it could be met with a 10% protein, 5% L/P ratio. It also could be met with a 12.5% protein, 4% L/P ratio diet. Hence, the specific lysine requirements of a non-ruminant animal can be met by (a) increasing the amount of lysine in protein, or (b) increasing the relative amount of protein maintaining the same L/P ratio, or by (c) combining both approaches, i.e., narrowing the L/P ratio and increasing the percentage of protein.

Protein content is easily modified by selection. It might seem appealing, at first, to create opaque-2 and/or floury-2 synthetics and to select in them for higher protein content, particularly in view of Nelson's (NELSON 1969) finding that the effect of o_2 persists at higher protein levels. From such pools it would presumably be feasible to isolate inbreds with 12%, 14%, 16% or even higher protein levels, and at the same time maintain a desirable L/P ratio. There are some problems with this approach, however. Jugenheimer (unpublished data) found a high negative correlation between protein content (varying from 10% to 17% protein) and

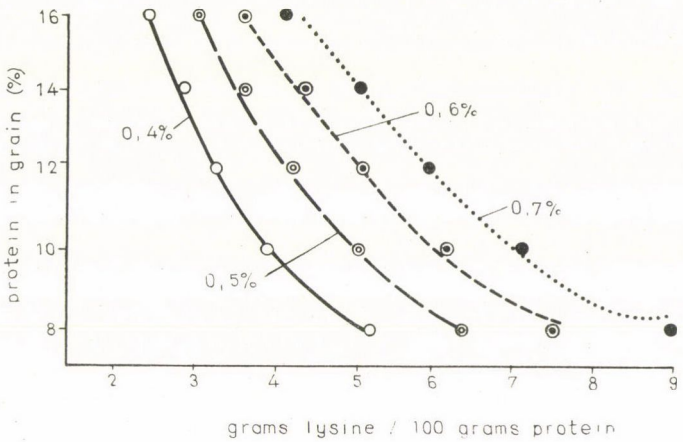

Fig. 1. Percent lysine in grain as functions of percent protein and lysine-protein ratio (2)

yield in maize. However, his data involved backcross recoveries of many standard inbreds and Illinois High Protein. Thus it might be expected that the higher protein hybrids involved more chromatin from I.H.P. than did the lower protein ones and yields might be reduced as a con sequence. However, WOODWORTH—JUGENHEIMER (1948) found that essentially no consequential relationship existed between protein content and yield in standard hybrids with protein contents ranging from 10—12.2%.

Table 3

Relationships of lysine and protein in experimental opaque-2 hybrids
(Unpublished data)

	Coefficient of correlation (r)			Mean and range		
	% Protein vs L/P Ratio	% Protein vs % Lys.	% Lys. vs L/P Ratio	% Protein	% Lysine	L/P
1967 — 3 ways	.13	.67**	.82**	10.6	.40	3.78
				10.0—11.1	.36—.45	3.51—4.22
1968 — Singles	.00	.62**	.83**	10.1	.42	4.11
				9.2—11.	.35—.50	3.47—4.65
1967 — half-sib	—.30**	—.01	.90**	11.0	.44	4.0
families				9.7—12.6	.33—.56	3.2 —5.1
968 — half-sib	—.17*	.47**	.80**			
families						

1968 — single yield vs % lysine = —.1972

* Significant at 5% level.
** Significant at 1% level.

It seems likely that problems with yield and other agronomic traits will be encountered if high protein content is a prime concern in modified protein maize breeding.

Work in this laboratory suggests that the L/P ratio may be modified by selection. The range in L/P ratio shown in Table 3 is substantial, particularly in the half-sib family material, which incidentally is based on an opaque-2 version of a narrow-base synthetic (AO_2). The 3-way and single-cross hybrids involved backcross-derived lines and perhaps were less variable.

Perhaps of more significance than the variability in L/P ratio is the positive correlation between percent protein and percent lysine, and the lack of correlation or a relatively low negative correlation between percent protein and L/P ratio. However, one cannot ignore the slight negative correlation between percent protein and L/P ratio in the half-sib family experiments. Do these data suggest that selection for higher protein in opaque-2 populations result in increased levels of zein? Would extended selection for protein content in such populations accumulate modifiers that would eventually result in maize with ordinary L/P ratios if lysine were not monitored?

Recurrent selection for L/P ratio, agronomic traits

Four modified protein pools are being selected for several characteristics at Illinois. The four pools are Iowa Super Stiff Stalk Synthetic (opaque-2 and floury-2 versions) and Illinois Disease Oil Synthetic (opaque-2 and floury-2 versions). Selection is based on biochemical properties, yield and other agronomic qualities of half-sib families. The mode of operation is essentially:

1. Two hundred ears of each synthetic are planted ear-to-row in replicated field trials. Yield, lysine and protein content are determined for each plot.

2. Each ear is also planted ear-to-row in an isolated seed block. A bulk sample of all ears is interplanted and used as a male on the detasseled individual ear rows, thus producing half-sib families.

3. Approximately 20 percent of the families are selected for the next cycle.

We are now in the midst of the first cycle of the four populations, hence no data are yet available. However, earlier work by Cooper and Dudley with Syn AO_2, a narrow-based synthetic, suggested that the effort could be worthwhile in the creation of more desirable breeding material, as well as adding to our basic knowledge.

Lysine-tryptophan ratio

It has been assumed by many breeders that if lysine is increased by selection than a parallel increase in tryptophan will also occur. The basic rationale behind the assumption is that a decrease in low lysine-tryptophan proteins (zein) and an increase in glutelins and globulins will bring about increases in both amino acids. However, the glutelins and globulins are groups of heterogeneous proteins varying in amino acid composition. If modifiers affect the action of the o_2 allele, presumably they would bring about differential production within each of the two categories and perhaps between them as well. Should certain proteins bearing smaller amounts of tryptophan be produced in greater amounts, when a particular modifier or group of modifiers is present, then it would follow that strict parallelism between lysine and tryptophan would not always occur.

J. E. Specht of this laboratory has found that correlation between lysine and tryptophan is not different from zero in synthetic opaque-2 varieties. His research is not finished,

although it seems highly improbable that another year's data will materially affect his findings.

The Specht finding may not be of immediate significance in the breeding of opaque-2 hybrids, since the level of tryptophan in opaque-2 maize is well above that level which will limit growth in non-ruminants. If, however, modification of the L/P ratio is successful, and ultra-high levels of lysine are attained, tryptophan may well become the first limiting amino acid in non-ruminant nutrition and appropriate attention will, of necessity, be paid to it.

Economics of modified protein maize

Much interest has been created in the United States with the apparent coming of high quality protein maize to commercial agriculture. The interest is motivated because the economics of corn-soybean-swine agriculture can be substantially affected. Other reactions are perhaps brought about by a lack of understanding, or by a negativism similar to that which was responsible for the attitude in the 1920's that hybrids were impractical for American agriculture. However, the economics of modified protein maize production is dependent on its use in the diets of swine, humans and perhaps poultry. It appears to have no advantage in the feeding of cattle or sheep although little experimental work has been carried out. Since about 50% of the United States crop is fed to swine and chickens, substantial effects could be felt in the demand for protein supplements, as soybean meal, should modified protein maize come into widescale production.

JENSEN *et al.* (1969) found that opaque-2 maize, supplemented with synthetic lysine, produced gains in 50 kg swine equal to standard diets composed of regular maize and soybean meal. This research, in addition to that carried out elsewhere, clearly establishes that reduction in high protein supplements is possible should opaque-2 maize become available.

IRWIN—ALLEN (1969) predict that should modified protein maize yield less than 90% that of regular corn that it will not be produced in the United States. If soybean meal is worth $ 80 a ton (2000 lbs.), then modified protein corn would have to yield 91%, that of regular corn if it were to be profitably grown. If soybean meal were worth $ 60 per ton, then a yield of 93% of normal corn would be necessary. They also predict that, should a balanced protein maize be perfected that yielded the same as regular corn, 5 000 000 fewer acres of soybean would be produced annually in the United States. At 95% of normal yield, the corresponding value would be 3 000 000 acres of soybeans.

Widespread adoption of modified protein hybrids in the United States, whether they be opaque-2, floury-2, the double mutant, or a still undiscovered type, is dependent on agronomic performance and the quality of the protein. We believe that formidable problems exist particularly with yield and softness of endosperm. They are solvable. Once solved, it seems likely that a very large part of United States production will be of the superior protein type. The economic complexities of that event are beyond analysis by a mere biologist.

Maize in 1986

To predict what maize will be like in 1986 does not require occult capacity, although it does require some critical appreciation and evaluation of research well underway or now complete. Certain economic considerations enter into these estimations and hence there is non-biological error imposed that cannot adequately be removed by a biologist. But it is virtually certain that maize will not be regarded collectively, but as special types adapted for particular industrial, feed or food uses. This has already happened in the United States on a small scale.

Waxy maize is produced for its branched-chain starch, amylose maize is grown for its straight-chain starch. We can expect that high oil maize will soon be grown because of its value in milling. Hence a precedent already has been established in identifying and producing corns with special properties.

In 1986 we anticipate that much maize grown in the United States will possess proteins of such high biological quality (0.55% lysine, 0.13% tryptophan) that protein supplementation will be required for only very young non-ruminants.

Substantial amounts of high oil corns will be produced for milling, possibly carrying 8—10% oil with yields similar to the best current hybrids having half as much oil. The use of such high energy corn will find a place in animal feeding as well.

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D. E. Alexander, J. W. Dudley, R. J. Lambert
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REFERENCES

Mertz, E. T.—Bates, L. S.—Nelson, O. E. (1964): Mutant gene that changes protein composition and increases lysine content of maize endosperm. Science, **148**, 1741—1742.

Alexander, D. E.—Lambert, R. J.—Dudley, J. W. (1969): Breeding problems and potentials of modified protein maize. From "New approaches to breeding for improved plant protein", Int'l. Atomic Energy Agency Pub., 55—65.

Lambert, R. J.—Alexander, D. E.—Dudley, J. W. (1969): Relative performance of normal and modified protein (opaque-2) maize hybrids. Crop Sci., **9** (2), 242—243.

Alexander, D. E. (1966): Problems associated with breeding opaque-2 corns, and some proposed solutions. Proc. High Lysine Conf., Purdue U., 143—147.

Paez, A. V.—Helm, J. L.—Zuber, M. S. (1969): Lysine content of opaque-2 maize kernels having different phenotypes. Crop. Sci., **9** (2), 251—252.

Nelson, O. E. (1969): The modification by mutation of protein quality in maize. From "New approaches to breeding for improved plant protein", Int'l. Atomic Energy Agency Pub., 41—54.

Woodworth, C. M.—Jugenheimer, R. W. (1948): Breeding and genetics of high protein corn. Am. Seed Trade Industry, Research Conf. Proc., 143—147.

Jensen, A. H.—Baker, D. H.—Becker, D. E.—Harmon, B. G. (1969): Comparison of opaque-2 corn, milo and wheat in diets for finishing swine. Jour. An. Sci., **29**, 16—19.

Irwin, G. D.—Allen, G. C. (1969): Urea and high lysine corn in cattle and hog rations. Economic and Marketing Information. April 30. (Purdue Univ. Coll. of Agr.)

SOME MICROCHEMICAL IDENTITY-REACTION OF MENTHA SPECIES TYPE CARVONE AND MENTHOL*

In the 6th Pharmacopoea Hungarica (1967) both the peppermint-leaf *(Menthae piperitae (folium* and the spearmint-leaf *(Menthae crispae folium)* are official. *Mentha piperita* (L.) em Huds. is the hybrid of *M. aquatica* and *M. spicata*. The spearmint leaves are known as the varieties and forms of *M. aquatica* var. *crispa* (L.) Benth. and as *M. spicata* (L.) em Huds. var. *crispa* (Benth.) Mansf., respectively. *M. crispae folium* may consist of glabrous or subglabrous leaves.

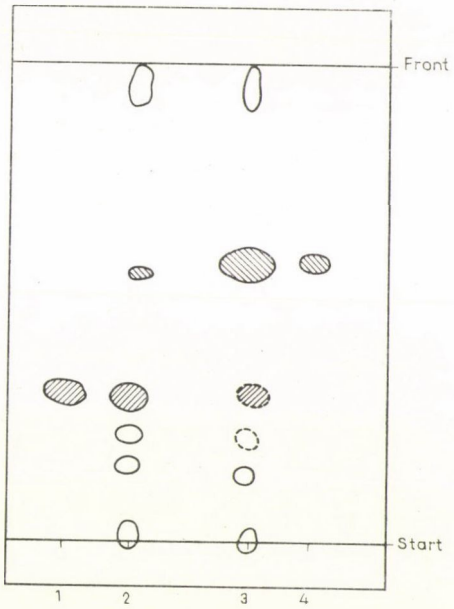

Fig. 1. Thin-layer chromatograms. 1) Menthol standard. 2) extract of *Menthae piperitae folium*, 3) extract of *Menthae crispae folium*, 4) carvone standard

According to BERGER (1950) a precise description of *Menthae crispae folium* as a drug seems almost impossible, because of the large amount of varieties and hybrids. Thus any description may deviate from the drug.

In his letter written to the ISO about the spearmint plant professor Harley stated: "*Mentha spicata* has two characters not possessed by either of its parent species: 1. presence of carvone, 2. subglabrous vegetative parts. It is presumed that these two characters arose in cultivation and were selected on account of their culinary value. Unfortunately *M. spicata* does not always possess these characters. A single gene with two alleles C/c controls presence of carvone; in the homozygous recessive condition cc, menthone is produced. Similarly a single gene with two alleles G/g controls presence of hairs; in the double recessive condition gg, the plant is very hairy, and has often been confused with *M. longifolia*."

All these facts make it necessary to perform the identification of the drug by other — e.g. chemical — methods too.

* The lecture was sent to the Symposium on "Progress in the field of plant drugs" Posnan, April 21—25, 1970.

The Pharmacopoea Hungarica prescribes thin-layer chromatographic method for the identification of the drug. The extract made from 2 g of material with light petroleum, is evaporated on water-bath. The residue dissolved in light petroleum is developed on Kieselgel G layer by a bensene-ethylacetate solvent system. 1 per cent vanillin dissolved in concentrated sulphuric acid is used as a spry-reagent. In *M. piperitae folium* the main spot can be identified as menthol by its colour and Rf value, and that of in *M. crispae folium* as carvone (Fig. 1).

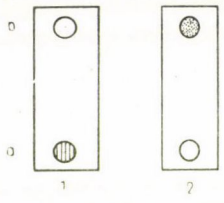

Fig. 2. Scheme of identity-reaction. 1) *Ol. menthae piperitae*, 2) *Ol. menthae crispae*, a) after treatment with 1 per cent vanillin in concentrated hydrochloric acid, b) after treatment with 2,4-dinitrophenylhydrasine

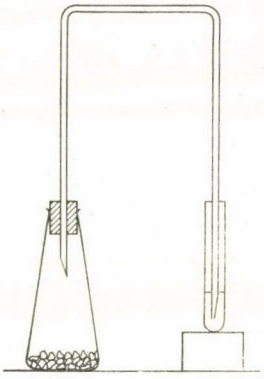

Fig. 3. Sketch of the apparatus

It was necessary to develop a rapid identification test using as small as possible quantity of basic material.

For the identification were used: 1. 2.4-dinitrophenylhydrasine solved in water or alcohol (STAHL 1962), 2. 1 per cent vanillin solved in concentrated hydrochloric acid.

The 2.4-dinitrophenylhydrasine gives precipitate with aldehydes and ketones, so it can be used for identification of carvone as a main component of the volatile oil in *M. crispae folium.*

The colour-reactions of volatile oils with 1 per cent vanillin in concentrated hydrochloric acid are different. *Oleum menthae piperitae* contains in a bigger quantity menthol and menthofuran (STICH—FLÜCK 1968). Menthofuran gives promptly bloodred colour-reaction while menthol needs heating to turn red. 1 per cent vanillin in conc. HCl was used by ROSENTHALER (1905), as early as in 1905 for volatile oil-reactions. He studied among others the volatile oils of peppermint and spearmint too. These reactions were performed using ml-s quantity.

The reactions were used for the identification of the distilled volatile oil of the dry drug and that of the developing green plants as well.

The test for identification of volatile oils of drug prescribed by the Pharmacopoea Hungarica consists of steamdistillation and volumen measurement. The identification can be performed from the oil received in this way. One drop of reagent put to one drop of oil on a slide will result different changes in accordance with the oil and reagent used, as follows: (Fig. 2) vanillin solution gives a violetred colour reaction with peppermint oil but it has no effect on spearmint oil; the oil of *M. piperita* does not give any reaction with 2.4-dinitrophenylhydrasine, while it forms orange coloured precipitate with the oil of *M. crispa.*

If the identification is wanted to be made before distillation of volatile oil, it is enough to put 0.10 g of leaves coarsely pulverised between two slides and to sublimate it by the common method on little flame. The water and the volatile oils distillated at the beginning of heating will condense on the upper slide in form of droplets, and this material may be used as an adequate subject for the reactions mentioned above.

The high sensitivity of both reactions makes them applicable for breeders too.

On the basis of plant habitus it is impossible to determine either the menthone or the carvone type of *M. crispa*. Thus the plant breeders have to elaborate a method for the type-determination of individual plants applicable as early as in their vegetative period.

The green plants for the tests originated from the material of experiment of varieties maintaining performed by the Experimental Station of the Scientific Research Institute for Medicinal Plants (Budakalász).

The plants were investigated three times, in shooting, budding and flowering phases. The reactions were always positive. The volatile oils of the green plant material containing much water cannot easily be microsublimated and the material in sufficient quantity cannot be placed between the two slides. The work can be performed with the well known simple apparatus (Fig. 3). In the receiver 5 mls of ethanolic solution of 2.4-dinitrophenylhydrasine is placed, with the end of a glass pipe in it. The chopped material with some mls of water is in the flask. The content of the flask is simmered for about 7 minutes on little flame; then a light orange colour will appear in presence of the peppermint and glittering orangered precipitate in that of the spearmint. A similar method can be used when the reagent is 1 per cent vanillin in concentrated hydrochloric acid. Under such circumstances colour reaction may appear or the solution in the receiver may remain colourless depending on the condensate.

The 0.50 g material needed for the test is corresponding to about two leaves. The plant can recover the loss of two leaves, and so the type of volatile oils produced can be tested during the vegetative period.

Summing up the results the solution of 2.4-dinitrophenylhydrasine is suitable as well as 1 per cent vanillin in concentrated hydrochloric acid for an identification of volatile oils and therefore for that of both spearmint *(Mentha crispa)* and peppermint *(Mentha piperita)* plants.

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REFERENCES

Berger, F. (1950): Handbuch der Drogenkunde, Erkennung, Wertbestimmung und Anwendung. Vol. 2. Folia. Verlag Wilhelm Maudrich, Wien.

Harley, R.: ISO/TC-54/UK-57/814 Document No. 66/30593.

Pharmacopoea Hungarica 6. (1967): Medicina Könyvkiadó, Budapest.

Rosenthaler, L. (1905): Ein Beitrag zur Vanillin-Salzsäure-Reaktion. Z. f. Anal. Chemie, **44,** 292—301.

Stahl, E. (1962): Dünnschichtchromatographie. Ein Laboratoriumshandbuch. Springer-Verlag, Berlin—Göttingen—Heidelberg.

Stich, O.—Flück, H. (1968): Die Zusammensetzung von genuinen, extrahierten und destillierten ätherischen Ölen einiger Mentha-Arten. Pharm. Acta Helv., **43,** 411—446.

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CHRONICA

ERNŐ OBERMAYER

1888—1969

It was on the 27th May 1969, at the age of 81, after an illness of some duration that Ernő Obermayer, corresponding member of the Hungarian Academy of Sciences, director-general of research work died. His death broke a long successful carrier, and Hungarian scientific life has been once again deprived of an excellent plant breeder, a talented creative agricultural expert. Ernő Obermayer's fruitful work was a great example for young experts not only in Hungary, but also on a world level, that is why the death of this supporter of the profession and good friend of his co-workers was so sad.

Ernő Obermayer was born on the 13th December 1888 at Somlószőllős, Veszprém county, as son of a farm manager. After the early death of his father the family moved to Pécs, where his mother was employed in a post-office, so he finished the secondary school at Pécs. He continued his studies at the Technical University in Budapest, on the Faculty of Chemical Engineering and obtained his diploma in 1910. During his university studies Prof. Elek 'Sigmond exerted a great effect on him, moreover, it was he whom Obermayer was indebted for directing his scientific work in all his life toward the problems of Hungarian red peppers. Even in the diploma work Prof. 'Sigmond gave the young chemist — who was extremely interested in agricultural problems — the task of examining the oil content and oil quality of Hungarian red pepper.

After having obtained his diploma Ernő Obermayer worked for several months in the laboratory of the sugar-works at Kaposvár; from the beginning of 1911 on, however, he worked already at the National Plant Breeding Institute at Magyaróvár. The famous director of the Institute established some years earlier (1909), Emil Grábner, took the young chemical engineer to work with him, in order to train him in plant breeding too, thus gaining a co-worker in the

chemical relations of breeding work. The seven years spent at the National Institute for Plant Breeding left imperishable marks in Ernő Obermayer. He got acquainted with the manifold questions of plant breeding, even performed creative work when dealing with the flowering biological problems of more important bread grains. Results of his researches performed at that time are appreciated even today all over the world. It was then that Ernő Obermayer engaged in plant breeding which he carried on in all his life with great enthusiasm.

In early 1918 he began to work at the National Institute for Chemistry, but was charged immediately with the pioneer work of red pepper breeding and sent to Kalocsa, to the Chemical Experiment and Paprika Experiment Station. Red pepper growing which has made a rapid progress at Kalocsa during the first world war could no longer do without systematic management, since there was a lot to be desired as regards varieties and especially the quality of ground red pepper. With nearly ten years of work Ernő Obermayer considerably improved the growing and processing conditions of the Kalocsa district. First of all he improved varieties, then elaborated the adequate growing and technological methods.

By successfully arranging the Kalocsa district he won his superiors' confidence and was charged with an even greater task: to improve red pepper growing and breeding in the district of Szeged. In May 1927 he was appointed leader of the experiment station of Szeged. His task here was greatly facilitated by the fact that he could begin work with varieties improved earlier at Kalocsa, and had also experiences in extending red pepper growing. Through Ernő Obermayer's expert work the world famous "szegedi paprika" regained its old reputation. Although from July 1931 he was given charge over the Institute for Plant Growing and Plant Breeding Experiments, Szeged too, thus his scope of subjects became considerably wider, he continued to study the questions of red pepper breeding and growing. He was not prevented from doing this work even by the troublous and uncertain times of the second world war, always the "favourite plant", red pepper was in the centre of his interest. His attention was not, however, focussed exclusively on Szeged, he was concerned also about the problems of the prosperous red pepper growing district of Kalocsa. It was he who suggested to divide the tasks between the two red pepper districts: Szeged has become the district of hot red peppers while Kalocsa remained that of non-hot (capsaicin-free) red peppers.

Ernő Obermayer was dealing with the problems of red pepper breeding and growing for more than fourty years. As early as in 1920 he gave five varieties to test in practice, then continued to improve them, or replaced them by new ones. These varieties included both hot and non-hot ones. He started breeding work always with local varieties; this was the only secret of his success. Later on co-workers helped him in his work, this, however, only widened and increased his success. In 1959 three of his varieties were given state certification: Szegedi non-hot 47-25, Szegedi non-hot 47-137 and Szegedi hot 48-163. His heritage is utilized by his co-workers at Szeged and Kalocsa.

Ernő Obermayer's activity was not, however, completely absorbed by the manifold problem of red pepper breeding. He dealt with pleasure with other growing problems of the southern Great Plain too, and it is not surprising at all that he was able to produce results of standing value here too. Such problems were those of onion at Makó, sorghum in the eastern part of Csanád county, soybean and rice as well as cotton, ricinus and cumin as side-lines. The questions of rice growing should be especially emphasized, since Obermayer won everlasting gratitude by solving them.

The first attempts to introduce rice growing in Hungary date back several centuries. Since, however, these attempts failed for a long time, the general opinion was that rice growing was hopeless in Hungary, it could not succeed, due to climatic obstacles. But Ernő Obermayer and his co-workers Sándor Herke and Ferenc Somorjai proved this belief wrong. In 1932 Ernő Obermayer started an extensive six years experiment and examined the production value of some 103 rice varieties collected from 14 countries. During this work the variety Dunghan

Shali was found to be the most useful basic material for rice breeding. This Soviet variety (breeder: Bjelov) proved good in experimental growing already; in 1940 it was used for commercial production in many places and in 1944 was given a preliminary certification. Ernő Obermayer's untiring work introduced rice growing in Hungary for good. His successors had no more difficulties in continuing rice breeding and extending rice growing. In 1944 rice growing area was already 8500 cad. yoke and the yield 34.8 q/ha. At present rice growing area is 35 000 cad. yoke in Hungary and the average yield is about 20 q/ha.

Ernő Obermayer's scientific activity is witnessed by some 180 publications (books, papers, articles etc.) apart from all those living results which even today increase the activities of certain plant growing branches. Besides his scientific work he took part with pleasure in organizing and directing scientific and professional work. Although in 1956 he finished his official work and retired, he did not choose the well deserved rest but continued to work. His excellent work was recognized from more than one sides.

So he became doctor of sciences in 1952, then in 1953 corresponding member of the Hungarian Academy of Sciences. In 1949 he won the silver medal of Kossuth Prize, in 1963 he was awarded the Order of Labour, in 1968 the gold medal of the Order of Labour and became honorary doctor at the University of Agricultural Sciences, Gödöllő.

Ernő Obermayer's life was an example of exceptional creative work. The succeeding generations will always remember him with gratitude and he will remain an example to be followed by them.

GY. MÁNDY

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RECENSIONES

A. JÁNOSSY: *Herefajok termesztése és nemesítése* (Cultivation and breeding of clover-species). Akadémiai Kiadó, Budapest, 1968.

The work published in the Monography Series of the Department for Agricultural Sciences of the Hungarian Academy of Sciences under the editorship of Gy. Mándy, makes the detailed monographic treatment of the *Trifolium* species available in Hungarian language too. The monography consists of four parts; from a practical point of view parts III and IV elaborated by A. Jánossy and discussing the cultivation and breeding of the individual species are the most important. The biological bases of cultivation and breeding — taxonomy, morphology, physiology, pathology and chemical composition — are provided by co-authors.

The book deals primarily with *Trifolium* species produced in Hungary in the field, or providing valuable protein resources in the pastures and meadows. Data can be found, however, on species of minor importance, ones that might be introduced, and exclusively wild species too. Authors not only collected literary data, but in some chapters presented the results of their own investigations too. Thus the book has the merit of serving as a basis for further researches on the subject, too.

The size of the work is 436 pages of which 23 are occupied by an English summary that follows the original structure. Understanding is promoted by 178 figures and 107 tables, while easy handling is ensured by a detailed index. References given after each chapter make further studies possible.

As an introduction the agricultural importance of clover species excelling in protein supply is discussed by Jánossy.

Part I contains the biology of clover species in 9 chapters, on 190 pages. In chapter 1 Boros—Szabó present the taxonomy of *Trifolium* sp. and give a survey on the family *Fabaceae (Papilionaceae)*, further on the genus *Trifolium* and the importance of wild species growing in Hungary. They give a taxonomic key to wild and cultivated species, then deal with the origin, distribution, ecological requirements and forms of species important in cultivation. In chapter 2 Paál summarizes the chromosome relations of clover species, while in chapter 3 Szabó gives the morphology of 20 major species in detail with rich — partly coloured — illustrations. Teratomes occurring in *Trifolium* species are treated by Papp. In chapter 4 Paál discusses the internal morphology of major species, and completes the relatively few references with original studies.

In chapters 5, 6 and 7 dealing with the physiological processes, the physiology of germination is presented by Szabó, the details of metabolic processes by Pozsár, while the physiological conditions of development by Mándy. The flowering biology of more important clover species is treated by Bányai in chapter 8 with a detailed study of factors influencing flowering, pollination and fertilization. Part I is completed by the genetic study of major species compiled by Jánossy.

Part II discusses the relations of clover species and environmental factors in four chapters. The general influence of climatic, soil and geographical factors in the cultivation of clover species is described by Jánossy in chapters 1, 2 and 3. The effect of the

living environment is dealt with by chapter 4 in detail. Komlóssy writes on the fungal diseases of *Trifolium* species and the possible control methods, while Holly gives a detailed and up-to-date analysis of virus diseases. The pests and the various methods of pest control are described by Manninger, with rich illustration. Among the flowering parasitic plants the taxonomy, distribution and the way of living of *Cuscuta* species, as well as damages done by them and the methods of control are discussed at length by Szatala. Finally, information is given by Gimesi on the Hungarian problems and experimental results of chemical weed control.

Part III deals with the clover species from the practical point of view of field production. In chapter 1 Jánossy describes the demands of clover species suitable for fodder production in Hungary too, as well as the bases and practical execution of appropriate culture practices. He deals primarily with the cultivation of red clover in detail, supporting it with the data of his own experiments. In addition to the species grown on a smaller area he gives account of the species recently introduced or just being introduced in Hungary. Chemical compositions of the fodder yield of the individual species are presented by Koch in chapter 2. In chapter 3 dealing with seed production Jánossy discusses at length the seed production of red clover, and analyses the components of seed yield on the basis of his own experiments. The chapter includes the seed production of other species too, and the defoliation of seed clovers compiled by Gimesi.

Three chapters of the closing part, Part IV, deals with the breeding of clover species as elaborated by Jánossy. After the historical survey of breeding chapter 2 presents the methods of breeding, as reflected primarily in Jánossy's experiments carried out with red clover. He discusses in detail his type analyses performed by using Hungarian local varieties and a world variety collection in order to produce an adequate basic material for breeding. After a summary of red clover breeding methods by selection and crossing, methods and results of producing tetraploid forms are presented. Finally, in the last chapter of the book improved domestic and major foreign varieties are described.

The monography has fulfilled its task: besides giving useful information, it called attention to the necessity of a further theoretical and practical study on agriculturally important clover species. The detailed English summary allows other countries too to examine the cultivation of clover species in Hungary and the investigations carried on in this subject.

Z. BŐJTÖS

Magyarország erdőgazdasági tájainak erdőfelújítási, erdőtelepítési irányelvei és eljárásai (Directives and Methods for Afforestion and Forest Plantation in the Forest-Regions of Hungary). Országos Erdészeti Főigazgatóság, Budapest, 1963—64, 7 + 3 volumes.

A vast work well representing the development and standard of sylviculture, was added to the special literature of this country when these 10 volumes were launched by the Chief Administration of National Forestry, published and carried into effect beautifully by the Mezőgazdasági Kiadó (Agricultural Publishing House).

The present series indicates an important landmark by showing that the authorities in charge in Hungarian sylviculture — being fully conscious of the requirements of life and of the enormous progress in science as well as in practice, — they have adopted modern sylviculture based on biological aspects supplanting the old method of cadastral survey. It has been recognized that the forest is a biocoenosis and even more: a biogeocoenosis developed as a result of living beings and their habitat; its essential element is life, the collective of living beings. If, therefore, we aim, in the interest of people's economy, at the products of the forest, the best way seems to be to tackle and direct its development as required by considering it alive.

Thus, as a basis of sylviculture and afforestation, the main aspect of this series

of books starts from the basic theoretical knowledge, first of all, from the coenology of forest-joinings and its applied branch: forest typology. Authors make use of the results of geobotany, oecology, soil science, meteorology, geomorphology and geology, the work also submits elaborated directives and the measures to be taken.

The work containing 10 volumes, has been brought about by a collective counting numerous members and directed by the sylviculture main department of the Chief Administration of National Forestry. That collective consisted of 92 excellent experts having amplest experiences in this field: the best proof of the great improvement and efficiency of domestic agriculture.

The first volume of the series being compiled by István Danszky and Ferenc Rott, bears the title: "General Directives. The Mapping of Forest- and Habitat Types". The introduction enumerates the sylvicultural groups of regions, members of the editorial collective and the special committees. Then follows a discussion on the situation and developing of sylviculture, showing within that frame forestry regions, types of forests and sites as well as the problems of the continuative education in forest typology. This is followed by the description of our aims concerning the policy of tree species and production. Authors then discuss the problems concerning renewal of our forests by forest types and the restoring of ruined forests, summarizing also literature referring to the above.

The following chapter deals with plant geography conditions in our forestry regions. On the basis of the abovementioned coloured map, our country is divided into 6 such groups of region: I. West Transdanubia II. South Transdanubia, III. The Plain in Northwestern Hungary; IV. The Transdanubian Central Range of Mountains; V. The Northern Central Range of Mountains; VI. The Great Hungarian Plain. The chapter based on most up-to-date plant geography issues offers a competent characterization of the regions concerned. I should like to stress that this arrangement and the enclosed map entirely agree with Hungary's floristical structure. A good example that if we consider natural vegetation either from theoretical or from practical viewpoints, the result will be almost identical. This proves, at the same time, the justness of the basic theory in the work and that of the guiding principles derived from it. That part written on floristical and coenological basis, is followed by the description of methods in the mapping of forest- and habitat type in mountainous and hilly regions as well as that of sandy, glatland hard ground and of the alkali soil sites.

Hereafter is found — for each sylvicultural region, — the enumeration of data according to geographic, rock- and soil science, climatic, plant geographic aspects, indigenous and cultivated tree species, the joining of forests, forest types and types of stands. Then follows the terminology of the relevant notions, a brief numerical summary of important sylvicultural books and, finally, a very detailed enumeration of the literature cited in the whole work. This has been produced by István Csapody amounting to 36 pages.

The introductory volume is followed by the practical part dealing with each region separately. These volumes contain references to the forestry regions of: I. West Transdanubia, II. South Transdanubia, III. The Plain in Northwestern Hungary, IV. The Transdanubian Central Range of Mountains, V. The Northern Central Range of Mountains, VI. The Great Hungarian Plain. In each of these volumes we find a general information on the directives regarding geographical site, geology, geomorphology, soil science, forest typology and the policy of tree species. Besides, there is a detailed description of forestry regions belonging to the groups of regions.

These 7 volumes giving the essentials of the work, are complemented by 3 other works of smaller volume. The first of them is the work of Prof. Antal Májer, founder of the scientific forest typology in this country, under the title: Representative Plants of Forest- and Site Types. The book

enumerates the forest types, the tree species they are made of together with the characteristic underwood species. After this we are shown the prototype plant species in 139 coloured pictures made after the artistic water-colours of Vera Csapody.

A very important part of the series is also the volume written by Zoltán Járó under the title: "Soil-Types" describing the site, soil, soil-development and the system of genetical soil types; after this author demonstrates the characteristic sections of different soil-types on 50 coloured Tables made after the pictures of Pál Strauss containing also a brief description. The volume ends with the part containing general information.

The 10th part of the series is the coloured map (1 : 500 000) of forestry groups of regions and within this that of the regions. The work of István Csapody—Vera Csapody —Ferenc Rott under the title: "Forest Trees and Shrubs" may be considered the 11th volume of the series.

The whole is characterized by the vast material of pictures consisting of text illustrations, photos and of Tables that are partly coloured.

As mentioned above, the vast work has been brought about through the contribution and collective work of 92 experts. This explains the fact that — without detracting anything from the merit of the work — here and there occur insignificant errors, and that the ways of elaborating are not always uniform and consistent. On the other hand, the slight differences displaying themselves in the volumes discussing region-groups might be due to the differences of fundamentals of certain fields.

The volume of ten books — containing 4115 pages, — the vast material held in it, the summaries easy to survey, do credit to the 92 authors and to the work of István Danszky achieving the very hard task of compilation as well as to the beautiful outfit of the Mezőgazdasági Kiadó.

That work, summarizing the high-standard material of scientific and practical knowledge of Hungarian sylviculture is the best proof of the level gained — a proof for our sylviculture to improve, surely and resolutely, on that basis with the hope that the work is going to arouse many a new thought and viewpoints serving further development. Thus, this series of books represents the landmark of a new epoch in the history of sylviculture, and an almost indispensable source for the experts with most various activities.

Z. E. KÁRPÁTI

G. FARKAS: *Növényi anyagcsereélettan* (Physiology of plant metabolism). Akadémiai Kiadó, Budapest, 1968

With the development of the molecular aspect of biology many branches of biology, among others plant physiology, have been revolutionized. Numerous new results have been published and many old problems, thought to have been solved, have had to be re-examined.

The present state of plant physiology and the gradual change in the approach to it are presented in this book by Gábor Farkas, intended for plant physiologists, specialists interested in related fields and last but not least, the research workers of the future — the students.

The interesting problems of metabolical physiology (dealt with in the book) are: I. photosynthesis, II. respiration, III. metabolism of lipoids, IV. autotrophy of nitrogen and sulphur, V. metabolism of amino acids, VI. metabolism of nucleotides, VII. metabolism of nucleic acids, VIII. metabolism of plant proteins and finally IX. secondary metabolites. Among these nine chapters those on photosynthesis, respiration, and the metabolism of nucleic acids and proteins are discussed in fullest detail.

The chapters sum up the knowledge established so far, but in addition they draw attention to the most up-to-date problems and to the difficulties of investigations, and outline ways of solving them. Within this context the reader is made acquainted with the new experiments and methods which have helped to answer the questions raised, and at the same time is presented with the

essential changes in approach. In this respect the presentations of chlorophyll biosynthesis, mitocondrial electron transport and the "in vivo" role of soluble oxidases is very interesting and valuable. The interpretation of the concepts of "metabolic sink" and "pool" in chapter V, and the discussion of enzyme induction in plants in chapter VIII, will rightly call the reader's attention and compel admiration, as well the general presentation of the problems raised.

When dealing with the metabolism of nucleic acid, the author gives a summary of nucleic acid types known so far, and then presents the experimental data which points to the existence of m-RNA in higher plants.

In chapter VII dealing with the protein metabolism of plants, the author gives a review of genetic information and data on metabolic control, and then briefly discusses some special relationships of nucleic acid and protein metabolism in higher plants. With the latter he does not more than indicate the direction which investigations should take.

The value of individual chapters, especially of those dealing with biosyntheses, is enhanced by well constructed tables and figures, tables summarizing chemical structures of frequently occurring compounds are specially useful.

Unfortunately, some important questions of metabolical physiology are not included in the book. For example no account is given of the present state of plant hormone research, although one of the most important changes in approach has taken place in this field. The author does however refer quite correctly to the key position of auxins, gibberellins and kinetins. In chapters dealing with photosynthesis and respiration, the influence of environmental factors — light, temperature — is also omitted. Readers would gladly hear of them as well.

Gábor Farkas's book is not a text-book, but the author did not intend to write such a book. It is not directed at those wishing to acquire a fundamental knowledge of plant physiology. A research worker taking active part in experimental work and having a good knowledge of the literature, addresses himself not only to the plant physiologists of today, but also to those of the future who will have to develope a quite new plant physiology. Therefore the book can be recommended to all those who possess an adequate fundamental knowledge and wish to deepen it. It will also be valuable in demonstrating the possibilities to future plant physiologists by testifying that plant physiology has become a much more up-to-date branch of science than is generally realised.

M. DÉVAY

L. DEME, S. IMRE: *A magyar nyelvjárások atlasza* (Hungarian Dialect Atlas), I, (1—192 maps), Akadémiai Kiadó, Budapest, 1968.

The Hungarian dialectologists — under the leadership of academician Géza Bárczi — have compiled the first part of the Hungarian Dialect Atlas planned to consist of 6 volumes as a result of several decades' work.

The example of Gilliéron's linguistic atlas of France (Atlas linguistique de la France. Paris, 1902—1910) which contained 1920 maps was followed by many all over Europe; the neo-Latin and Germanic nations have published a considerable number of linguistic atlases for various purposes by now. Although in Hungary two stocks of words were summarized and published already in the course of the 19th century (in 1838, then from 1893 to 1901) ensuring a distinguished place to Hungarian dialectology on a European scale too, still it is the present publication that means — besides its national importance — a great progress internationally as well.

In the attractive, hard-covered box there are 192 map-sheets which can be taken out when used. The greatest advantage of the work is that it consists of word-cards and — in order to avoid misunderstanding — presents the subject matter by writing the dialectic data themselves onto the map instead of illustrating it by means of standard symbols and figures. Authors often complement the map-sheets with general notes containing factual or methodological information on the whole field of research or occasionally on a major part of it.

Those contributing to the Dialectic Atlas have the great merit of presenting on the maps data collected in territories populated with Hungarians of neighbouring countries as well (Croatia, Slavonia, Banat, Transylvania, Slovakia, Csallóköz [territory between two branches of the Danube in the Little Plain], Burgenland, etc.).

The main characteristics of the Dialectic Atlas are: it presents data of source value; all of its data originate from records made by qualified dialectologists on the spot; its data reflect the answers of at least two but often more persons supplying data; data collected at the sites of research were checked later by the co-workers on the spot; the basic principle of its phonographic system is phonetics and it is based on the symbols of Hungarian orthography.

The map-sheets are divided into the following subjects: cereals and their plant parts as well as their weeds; cultivated plants; fruits; soil cultivating implements; the cart and its parts; horse- and ox furniture; harvesting, thrashing. The great majority of the 192 maps, i.e. 172 are of word geographic nature: they present the concepts contained in the head-pieces of maps (e.g. sunflower, buckwheat, mulberry, alder, rosehips, [corn]-snapping, -husking, -shelling, etc.) are expressed by at the various sites of research. The subject matter of 14 maps has been collected for a phonetic purpose: local variations of pronouncing stubble field, waste land, furrow, parsley, paprika, grass, hay, axle, straw, thatch, tailings, etc. were to be found. 6 maps are of morphological character, it is suffix, sign or affix that are important on them.

Our linguistic science has made up for a considerable time lag by preparing the first part of the Hungarian Dialectic Atlas and parts II—VI to be published later, since under the increasing influence of industrialization, radio, press, television and communication, dialects are becoming more and more faded, they perish and melt into the standard language. This work may be of good service not only to Hungarian linguists (dialectologists, etimologists, grammatists, purists, etc.) but also to the linguists of the neighbouring nations (Slovakians, people of the Carpathian Ukraine, Roumanians, Serbians, Croatians, Slovenians, Germans). At the same time it may excite the interest of other specialists (those of etnography, geography, botany, zoology, agriculture, literature) too, and can be of use even for linguists or other interested specialists of countries distant from Hungary.

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